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Teaching Visual Effects for Audiovisual Production using Digital Learning Objects

Dissertation for obtaining the Doctor's Degree in
Digital Media

Advisor: Prof. Ph.D. Nuno Manuel Robalo Correia, Full
Professor, DI/FCT/UNL

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FACULDADE DE
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UNIVERSIDADE NOVA DE LISBOA

December 2020

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Dedication

I dedicate this work to God, to my incredible wife Kátia Giroto Rodrigues Maschio, to my loved son Diogo Rodrigues Maschio, and to my father, mother, mother-in-law, and sister, first of all.
Right afterward to Portuguese dear and amazing friends Ricardo Gaspar Viegas, Susana Teixeira and their son Xavier Teixeira Viegas.
For sure to my spectacular advisor, Prof. Ph.D. Nuno Manuel Robalo Correia.
Also, to the friendships made during the doctoral journey: Camila Wohlmuth da Silva, Janna Joceli Omena, Arianna Mencaroni, Lígia Duro, Greicy Coelho.
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Resumo

Esta pesquisa de doutoramento trata sobre a produção de um objeto de aprendizagem digital para o auxílio à atividade docente, mais especificamente na execução de exercícios práticos para a produção de efeitos visuais em audiovisual em cursos de nível superior.

O estudo realiza uma revisão da literatura sobre o uso de Tecnologias da Informação e Comunicação na educação, objetos de aprendizagem, objetos de aprendizagem digitais e aprendizagem combinada. Na investigação, busca compreender os métodos e procedimentos de design, implementação, avaliação e validação de tais tecnologias para aplicar ao protótipo a ser desenvolvido. Apresenta as etapas de desenvolvimento do protótipo e todos os desafios enfrentados para sua concretização.

Com a ferramenta totalmente funcional já desenvolvida e testada, são demonstrados os procedimentos metodológicos utilizados para seu uso e avaliação. A pesquisa de campo encontra-se relatada e documentada, apresentando os resultados alcançados.

Foram utilizados formulários com os alunos participantes da pesquisa, além de análise cega sobre os trabalhos práticos por eles desenvolvidos. Tais dados são analisados e apresentadas as reflexões e contribuições advindas de todo este processo de experimentação.

Foi possível concluir que a ferramenta (objeto de aprendizagem digital) projetada conseguiu atingir seus objetivos e responder às perguntas de pesquisa que o fomentou, tendo sido considerada pelos participantes como útil, motivadora e funcional para o auxílio do processo de aprendizagem.

A análise cega empreendida não demonstrou diferenças significativas entre os grupos controle e teste na qualidade dos trabalhos executados, contudo, evidenciou a possibilidade de utilização de outras metodologias em conjunto com as utilizadas, para aprimoramento de pesquisas futuras.

Acredita-se que toda a discussão e experimentação realizada e documentada atinge positivamente seus objetivos e demonstra sua contribuição ao auxiliar na discussão científica sobre a efetividade pedagógica dos objetos de aprendizagem digitais, criar um destes objetos/software inédito, além de apresentar as metodologias de produção utilizadas.

Palavras-chave

Objetos digitais de aprendizagem, Aprendizagem combinada, Ensino híbrido, Movimento de correspondência, Efeitos visuais, Produção audiovisual.

Abstract

This Ph.D. research deals with the production of a digital learning object (DLO) to aid teaching activity, more specifically in the execution of practical exercises for the production of visual effects (VFX) in audiovisual in higher education courses.
The study performs a literature review on the use of Information and Communication Technologies (ICTs) in education, Learning Objects (LOs), Digital Learning Objects (DLOs), and Blended Learning (BL). In the research, it seeks to understand the methods and procedures of design, implementation, evaluation, and validation of such technologies to be able to apply to the prototype to be developed. It presents the stages of development of the prototype and all the challenges faced for its realization.
With the fully functional tool already developed and tested, the methodological procedures used for its use and evaluation are demonstrated. The field research is reported and documented, presenting the results achieved.
Forms were used with students participating in the research, in addition to blind analysis of the practical work they developed. Such data are analyzed and the reflections and contributions from this whole experimentation process are presented.
It was possible to conclude that the tool (DLO) designed managed to achieve its objectives and answer the research questions that fostered it, having been considered by the participants as useful, motivating, and functional in helping the learning process.
The blind analysis undertaken did not show significant differences between the control and test groups in the quality of the work performed, however, it evidenced the possibility of using other methodologies in conjunction with those used, to improve future research.
It is believed that all the discussion and experimentation carried out and documented reaches its objectives positively and demonstrates its contribution in to assist in the scientific discussion about the pedagogical effectiveness of DLOs, create an unprecedented DLO, in addition to presenting the DLOs production methodologies used.

Keywords
Digital learning objects, Blended learning, Match moving, Visual effects, Audiovisual production, Cinema.

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Lists of Abbreviations, Acronyms, and Symbols

APA – American Psychological Association.
AR - Augmented Reality.
BECTA – British Educational Communications Agency.
BL – Blended Learning.
CAPES – Coordination for the Improvement of Higher Education Personnel is a foundation linked to the Ministry of Education of Brazil that operates in the expansion and consolidation of stricto sensu postgraduate courses in all Brazilian states (Portuguese: Coordenação de Aperfeiçoamento de Pessoal de Nível Superior – CAPES).
CAT - Thesis Monitoring Committee (Portuguese: Comissão de Acompanhamento da Tese – CAT).
CCHLA – Center for Human Sciences, Letters and Arts (Portuguese: Centro de Ciências Humanas, Letras e Artes - CCHLA).
CCMD – Bachelor's Degree in Communication in Digital Media (Portuguese: Curso de Bacharelado em Comunicação em Mídias Digitais - CCMD).
CG - Computer Graphics.
CGI – Computer Generated Imagery.
CONSEPE – Teaching, Research, and Extension Council (Portuguese: Conselho de Ensino, Pesquisa e Extensão - CONSEPE).
CPEA - Certificate of Presentation of Ethical Appreciation (Portuguese: Certificado de Apresentação de Apreciação Ética - CAAE).
DAR – Display Aspect Ratio, as known as Image Aspect Ratio and Picture Aspect Ratio.
DEMID – Department of Digital Media (Portuguese: Departamento de Mídias Digitais - DEMID).
DESIRE – Development of a European Service for Information on Research and Education.
DLO – Digital Learning Object.
DVE – Digital Visual Effects.
FCT - The NOVA School of Science and Technology - NOVA SST (Portuguese: Faculdade de Ciências e Tecnologia - FCT).
GC - Graphic Characters.
HEODAR – Herramienta para la Evaluación de Objetos Didácticos de Aprendizaje Reutilizables.
ICF - Informed Consent Form (Portuguese: Termo de Consentimento Livre e Esclarecido - TCLE).
ICT - Information and Communications Technology.
IEEE - Institute of Electrical and Electronic Engineers.
IPCA – Broad National Consumer Price Index (Portuguese: Índice Nacional de Preços ao Consumidor Amplo – IPCA) It is considered, by the Central Bank, the official Brazilian index of inflation or deflation.
LDB – Guidelines and Bases Law of National Education (Portuguese: Lei de Diretrizes e Bases da Educação Nacional - LDB).
LO – Learning Object.
LOAM – Learning Object Acceptance Model.
LOAM – Learning Object Attribute Metric Tool.
LOEM – Learning Object Evaluation Metric.

LOQEVAL – Learning Objects Quality Evaluation.

LORI – Learning Object Review Instrument.

LTSC - Learning Technology Standards Committee.

MaxDiff - The MaxDiff (Maximum Difference Scaling) is a long-established academic mathematical theory with very specific assumptions about how people make choices: it assumes that respondents evaluate all possible pairs of items within the displayed set and choose the pair that reflects the maximum difference in preference or importance. It may be thought of as a variation of the Method of Paired Comparisons. Consider a set in which a respondent evaluates four items: A, B, C, and D. If the respondent says that A is best and D is worst, these two responses inform us on five of six possible implied paired comparisons.

MAXScript - MAXScript is the built-in scripting language for 3ds Max®.

MCTI – The Ministry of Science, Technology, and Innovations belongs to the direct administration of the federal government of Brazil (Portuguese: Ministério da Ciência, Tecnologia e Inovações - MCTI).

MEC – Ministry of Education is an organ of the federal government of Brazil (Portuguese: Ministério da Educação - MEC).

MERLOT – Multimedia Educational Resource for Learning and Online Teaching.

Model CIPP - Context, Input, Process, and Product.

MSDNAA - MSDN Academic Alliance is a Microsoft software program available to academic organizations (mainly colleges and universities). The institution pays an annual fee for the MSDNAA service, and the institution's departments, students, and staff can acquire licensed copies of Microsoft software. The list of software each college and university get is dependent on the agreements made by that particular organization, and specific software is available for specific departments.

NOVA – NOVA University of Lisbon (Portuguese: Universidade NOVA de Lisboa).

NPS – Net Promoter Score.

NREC - National Research Ethics Commission (Portuguese: CONEP - Comissão Nacional de Ética em Pesquisa). NREC's main attribution is the examination of the ethical aspects of research involving human beings. As a mission, it elaborates and updates the guidelines and norms for the protection of research subjects and coordinates the network of Research Ethics Committees of the institutions.

NREIS - National Research Ethics Information System Involving Human Beings (Portuguese: SISNEP - Sistema Nacional de Informação sobre Ética em Pesquisa Envolvendo Seres Humanos) is an internet information system on research involving human beings.

OER - Open Educational Resource.

Open ECBCheck – E-learning for Capacity Building.

PAR – Pixel Aspect Ratio.

Platform Brazil – (Portuguese: Plataforma Brasil) is a national and unified database of research records involving human beings for the entire REC / NREC system. It allows the surveys to be monitored in their different stages - from submission to final approval by REC and NREC, when necessary - enabling the follow up of the field phase, the sending of partial reports, and the final research reports (when completed).

Q4R – Quality for Reuse.

QEES – Learning Objects Quality in Learning Strategies for Education.

REC - Research Ethics Committees (Portuguese: CEP - Comitês de Ética em Pesquisa). The REC is an independent and multidisciplinary collegial that must exist in the institutions that carry out research involving human beings in Brazil, created to defend the interests of the research subjects in their integrity and dignity and to contribute to the development of research within ethical standards.

SAR – Storage Aspect Ratio.

SCOPUS - SciVerse Scopus is the largest database of abstracts and citations from peer-reviewed literature, with bibliometric tools to monitor, analyze, and visualize the research (ELSEVIER).

SFX – Special Effects.

SPSS - Statistical Package for Social Sciences (IBM product).

TAM – Technology Acceptance Model.

UFPB - Federal University of Paraíba (Portuguese: Universidade Federal da Paraíba - UFPB).

UFRGS - Federal University of Rio Grande do Sul (Portuguese: Universidade Federal do Rio Grande do Sul – UFRGS).

UML - Unified Modeling Language™ (UML®) it is a standard language for the elaboration of the structure of software projects. It can be used for the visualization, specification, construction, and documentation of artifacts that make use of complex software systems. In other words, in the area of Software Engineering, UML is a modeling language that allows representing a system in a standardized way (in order to facilitate pre-implementation understanding).

UNESCO - United Nations Educational, Scientific and Cultural Organization.

URL - Uniform Resource Locator.

USP - University of Sao Paulo (Portuguese: Universidade de São Paulo - USP).

VES – Visual Effects Society.

VFX – Visual Effects.

XLSTAT – Statistical Software for Excel by Addinsoft. The leading data analysis and statistical solution for Microsoft Excel. Software used for methodological MaxDiff proceedings.

Chapter 1 - INTRODUCTION

1.1. Work context

Undergraduate courses in higher education are very diverse and cover the most diverse areas of knowledge. In some of these areas, the articulation between the practice of the profession and its theoretical basis is interlaced from beginning to end in the entire process of training of these future professionals. However, this does not occur in all courses or areas of knowledge. The differentiated form of admission and hiring between public and private universities, competition between private universities themselves, and the criteria for recognizing courses in Brazil also directly affect the number of professors with different degrees hired, their salary, and consequently qualification and professional experience.

This research discusses these issues due to the correlation with the pedagogical practice that seeks to integrate the professional practice more into the theory, in the search for a more integral and preparatory training for the community.

Moreover, it focuses on the Audiovisual area and more specifically on the teaching of Visual Effects, where it seeks to research how much Digital Media and its new technologies are really generating real contributions in the pedagogical area, or if they would only be new means of content presentation. That is, to what extent the use of Digital Learning Objects in teaching really adds positively to the teaching and learning process, or whether they are simply a technological evolution in the way of presenting content, such as the exchange of overhead projectors for data shows, which to the learning process could have little meaning.

The development of this research was carried out in the Ph.D. course in Digital Media at NOVA University of Lisbon (**NOVA**), at NOVA School of Science and Technology (**FCT**) in Portugal, and the empirical research took place in the physical spaces of the Department of Digital Media at Federal University of Paraiba (**UFPB**) in Brazil, where the student of this Ph.D. is a teacher and had at his disposal better infrastructure and support from technical personnel for the execution of field activities within a stricter control of the methodological variables necessary for later validation of the collected data.

1.2. Presentation and motivation

The interest and professional experience of the researcher who authored this research have always permeated the areas of audiovisual and design, due to the interest in the production of special effects and visual effects in audiovisual. This inclination meant that his training was guided in the areas of production of audiovisual content and in parallel qualification in motion graphics, 2D and 3D animation, in order to achieve his greatest objective, which was the training in the production of more elaborate visual effects, where there is a union between special effects and visual effects in an audiovisual work.

After a few years working in parallel in the audiovisual production market and in his academic career as a teacher and researcher, it was possible to dedicate himself only to an academic career after joining a public higher education institution at a federal university in Brazil.

With his exclusive dedication to teaching undergraduate courses in the audiovisual area (Cinema and Audiovisual courses, Animation Cinema and Communication in Digital Media), it was possible to teach courses of the most varied, among them, courses with a direct relationship with the production of visual effects (**VFX**). In teaching this type of content, in which the integration between real and virtual images (match-moving) occurs, the aforementioned researcher may perceive certain difficulties during the teaching and learning process.

The production of match moving visual effects involves several techniques and technologies, in addition to the most varied concepts and theories, both in the cinematographic area and in the area of animation and computer graphics. This wide variety of knowledge that needs to be combined and integrated in a transdisciplinary way at the time of practical teaching activities usually presented great difficulty in its execution. The stage called (for pedagogical purposes) as "data collection" has always presented itself as the most critical to teaching when compared to other stages of production.

During this stage, students need to observe various parameters regarding the settings of the most diverse devices and shooting environment. Due to this huge amount of data to be analyzed, generated and collected (varying in quantity, depending on the degree of complexity of the filming), forgetting the collection of certain parameters can be crucial for not obtaining success later. That is, without the correct execution of this step, it may not be possible to carry out the audiovisual production as a whole, or in the best scenario, it is necessary to spend much more time to be able to execute it, exceeding the budgets or deadlines previously provided.

It was from observation of this difficulty during the teaching and learning process that the motivation for this research was found. Thus, the idea arose to propose the design of a prototype of a digital learning object (**DLO**) to aid in these teaching practices. A tool that could be shared in the educational and technical field through international **DLO**s repositories.

Bearing in mind that digital learning modes are becoming increasingly used in higher education to help students learn, encourage collaboration, creativity and provide students with the tools and skills necessary to work and live in an increasingly technological and digital world. Innovating, seeking to create a **DLO** to assist in the learning process and explore students' perception of the role of a **DLO** in learning the content in question would be a way of contributing to the pedagogical practice, as well as with scientific discussions about the real value the use of these technologies (**ICT**s and **DLO**s) in the teaching and learning process.

Innovation can be a way to improve the quality of education, helping to overcome crises of productivity and efficiency and changing the view that the sector is sometimes seen as resistant to change. This research seeks, therefore, to assist teachers and students in their teaching activities with the help that the prototype developed and freely shared in English can offer, in addition to bringing contributions to the academic community regarding the real pedagogical potential that new technologies and digital media can add to the teaching and learning process. This is done by inferring how the prototype developed and tested in a real learning environment actually behaved and what feedback was received from the students participating in the study regarding their real ability to assist in understanding the contents and carrying out the proposed practical activities.

Finally, another motivation for this research comes from the existence of disciplines in the Digital Media Communication course to which this researcher is a collaborator as an effective member of the teaching staff, which aims to assist the training of students in the relationship of digital media with the pedagogical area. In other words, disciplines such as "Design and Production of Pedagogical Objects" and "Dissemination of Educational Pedagogical Objects" allow that all the knowledge and methodological processes generated by this research can also be disseminated and shared with the students of the course, possibly generating new research and contributions in the respective area. And after this academic career challenge has been overcome, taking such contributions also to graduate programs to which this researcher will try later to be accredited.

1.3. The relevance of the research

Regarding the international context of research on the subject and the relevance of it, we have by way of example the work “The Knowledge Map: Innovative Classroom Practice with Digital Technologies” (Lewin, Savage, Haldane, & Whitton, 2011), research that is partially supported by the European Commission’s FP7 programme – project iTEC: Innovative Technologies for an Engaging Classroom (Grant agreement Nº 257566) - European Schoolnet and Seventh Framework Programme.

This work focuses on Digital Learning Resources studying the theme in the countries: Austria, Belgium, Estonia, Finland, France, Hungary, Israel, Italy, Lithuania, Norway, Portugal, Slovakia, and Turkey.

This document provides a review of current innovative practices in classrooms rather than a review of the potential of emerging technologies to change practices. That is, the focus is on teachers’ actual use of technologies in the classroom drawing on recent literature (2008 to date) of innovative uses. In addition, summaries of the national contexts for all the countries participating in the large-scale pilots are provided.

Technologies and software which are already making a difference to pedagogical practices in the classroom include learning platforms, social software, collaborative environments, augmented reality, tablet PCs and netbooks, smartphones and handheld devices, interactive whiteboards, multi-touch surfaces, learner response systems, and games-based learning. These technologies are supporting pedagogical changes such as increased collaboration, group work, cross-curricular approaches, self-regulated learning, and changes in the roles of teachers and learners. (Lewin, Savage, Haldane, & Whitton, 2011, p. 7).

This work reveals the importance of this type of study. In addition, it is possible to emphasize in the international context the research carried out jointly by the following six institutions:

- Fraunhofer Institute Systems and Innovation Research (ISI), Karlsruhe, Germany;
- Institute for Prospective Technology Studies (IPTS), Seville, Spain;
- Fondazione Rosselli (FR), Milan, Italy;
- TNO Strategie, Technologie en Beleid (TNO STB), Delft, The Netherlands;
- Ente per le Nuove Tecnologie, l'Energia el'Ambiente (ENEA), Rome, Italy;

- VTT Technical Research Centre of Finland (VTT), Tampere, Finland.

The title search "Science and Technology Roadmapping: Ambient Intelligence in Everyday Life (AmI@Life)" (European Science and Technology Observatory; JRC-IPTS/ESTO project, 2003), was submitted for approval to the Executive Committee of the European Science and Technology Observatory (ESTO) in August 2003. The research focuses on topics such as "Education and Learning" and "User Interfaces", besides plotting "Function Roadmap for education and learning applications".

> AmI@Life roadmap focuses on "trusted and universal access to Ambient Intelligence technologies within the context of everyday life", raising the potential of full IST integration in the everyday life of ordinary European citizens. It endorses a specific approach directed towards everyday life outside the professional sphere. Indeed, AmI in everyday life requires specific attention because there is no simple spill-over of technologies from the office to the home. Also there is the already-mentioned policy concern of exclusion. (European Science and Technology Observatory; JRC-IPTS/ESTO project, 2003, p. 11).

Thereby, these research projects highlight the international relevance of the topic and the importance of the contribution of the current research proposal.

Nevertheless, we can mention the situation experienced by all countries due to the Coronavirus (COVID-19), which forced all countries to implement quickly and in some cases even precariously, the most varied technologies in support of teaching, which overnight had to reinvent itself from the face-to-face paradigm for online distance learning (e-learning) without the time necessary for teacher training and retraining, adaptations, and preparation of educational material for digital practices.

Such context, served to highlight the current and previous trends to COVID, of presenting as motivating factors of contemporary education the implementation and use of information and communication technologies (**ICT**) in the educational process, its importance and need.

Research contributions

The major contributions of the research and the tool (**DLO**) designed will be mostly in the pedagogical scope, however consequently it will also generate identifiable technical/technological contributions. In an indirect way, it is possible to point out medium and long term socioeconomic contributions, although these are not possible to be measured and proven within the scope of this research.

<u>In the pedagogical scope</u>, the most relevant contribution will be in the empirical research to be performed with the students, in a real and controlled situation of teaching activity of related concepts, so that it is possible after the execution of planned exercises with and without the aid of the tool, measure together with the students participating in the research, how much **DLO** really served as a pedagogical element, helping in the learning process. Or if it showed itself only as an element of exposure and interaction with the content, with no help noticed in the learning process.

That is, through the exercises and forms that participants will perform and respond to, contribute to research in the area on the real effectiveness of using **DLO**s in teaching practice.

In addition to the contribution related to the validation of the use of a **DLO** in learning, empirical research will also seek to list elements that could be improved in the tool for future versions. Such evolution of the prototype (fully functional) has the intention of keeping it updated to be continuously used in order to assist in the teaching and learning process, both by the researcher and by any other professors in the area who want to use it in their teaching activities.

Even within the pedagogical scope, it can be inferred that the creation of the tool itself will also be a contribution to the area since no similar type of **DLO** was found in the most varied **DLO**s repositories surveyed, whether national (Brazil) or international. In other words, the development and dissemination of the tool and its instructional aspects for use in the educational context can be seen as a major contribution both to the area of research, creation, and validation of **DLO**s, as well as in the audiovisual area that will now have the tool in teaching activities related to the topic it covers.

In summary, the contribution will be extended to all professors of undergraduate courses such as Cinema and Audiovisual, Broadcasting (Radio and TV), Animation Cinema, Digital Media, Multimedia courses, among others that may include teaching visual effects in their mandatory or elective subjects in the respective pedagogical project. Consequently, the work will contribute to the students in their undergraduate courses during teaching and production activities, preferably guided by their respective teachers, as well as outside the learning context, in their productions in the university context or independently outside of it.

<u>In the technical scope</u>, the contribution can be punctuated primarily by its innovative aspect, because although it does not propose any new or unprecedented technology, it articulates several existing digital media technologies, available with free access, in order to shape and configure a new tool (**DLO**) from these firsts. This result of the research work, in addition to being fully functional and being freely disseminated for use, will also serve as an example and reference in encouraging other teachers to develop their own **DLO**s within their context of teaching content, which may be different from that the prototype presented here deals with.

Furthermore, because the tool is intended to make the data collection process more efficient, productive, reducing errors in data collection during the shooting of scenes in which the integration between real and virtual images (match-moving) will be carried out. That is, assisting in this data collection that is very complex and detailed, in addition to allowing to automate the transfer of the data to specific 3D computer graphics software (although the data collected can also be used in any other software without the automation of this transposition) contributes by offering an innovative solution to the previously mentioned issues.

In this technical/technological context, it is believed, therefore, that the contributions of the tool are due both to the possibility of assistance to overcome the difficulties of data collection and to its component of technological innovation, as until now there is no software or App available with the same specific purpose.

In addition, the tool developed, in addition to its use in an educational environment, can also be used in amateur or low-budget productions, taking its contribution beyond the educational sphere, and reaching amateurs, professionals and technology enthusiasts.

In the socio-economic context, it is believed that the contributions that can be generated are not immediately or short-term. This interpretation is due to the fact that teaching this type of audiovisual production for involving and requiring the intersection of different techniques and technologies, being more complex, qualifies students and consequently future professionals to produce more elaborated content, in addition to giving them greater creative freedom for their personal or professional productions.

Consequently, this contribution can allow a greater number of professionals trained to develop more ambitious projects in the labor market, resulting in two possible contributions to students. The first, the possible better competitiveness of such students to work in other labor markets (in addition to the local and regional) where technologies and the audiovisual production market are more developed. And the second, by assisting in the technological and training evolution of the professionals who currently work in the local market, leading to greater independence in the region that will not need to hire professionals from other regions of Brazil or the world, or outsource more elaborate audiovisual projects to other companies, from urban centers with more qualified labor.

In this way, it qualifies for local and regional audiovisual productions to become more elaborate (by using more robust visual effects), assisting in the technical development of the labor market, while reducing the concentration of these more demanding productions to the few companies already established in urban centers with a more consolidated audiovisual production market (such as in Brazil in the axis between the cities Rio de Janeiro - São Paulo).

Regarding the geographical area of action of the contributions of the work, it can be inferred that the tool will contribute scientifically with its empirical research results in the context of international discussions and reflections on the topic of the effectiveness of **DLO**s as pedagogical practices; in addition to contributing to higher education in both Portuguese-speaking countries such as Brazil and Portugal and expanding the contribution to an international context, by adopting the English language in its prototype and distributing it in international repositories.

This view is based on the fact that an audiovisual project in the context of the production of special effects requires multidisciplinary theoretical and technical content and its collaborative during execution. Also, by using many cutting-edge techniques and technologies in processes, as well as advanced hardware and software, these devices are normally used by default in the English language, where they are more readily produced and made available, taking longer to access versions in other languages (such as Portuguese).

That is, devices such as cameras, lenses, tripods, camera handling and stabilization equipment, reference objects, lights, devices for measuring the quantity and quality of light, in addition to the most varied software, are usually all used by default in the English language (either in countries like Brazil or Portugal), as there are not always Portuguese versions of manuals or software. In this way, it is believed that the adoption of the use of the English language in the prototype of this research would not cause strangeness either to undergraduate students in Brazil (where the empirical research was applied) or to students from Portugal, who also use of the English language in his academic and professional activities since the beginning of his career in higher education.

In this context, it expands the possibility of distributing the tool itself as it becomes more compatible with its availability in international repertoires of learning objects, in order to reach a broader and international audience.

1.4. Research questions and objectives

Research Questions

The research questions often originate in professional practice, as in this case.

The proponent is a university lecturer in the audiovisual area and realizing the difficulty of teaching more elaborate content, referring to more advanced concepts, techniques, and technologies of audiovisual production noticed the relevance of studying the theme of the production, use, and validation of a Digital Learning Objects (**DLO**) to aid in the educational process.

The research questions were subdivided into two classes, the global and the more specific ones.

<u>Global questions</u>

RQ1: Can Digital Learning Objects produce a sense of pedagogical gain in the teaching and learning process by students? Or are they just new media formats for transmitting the same content without necessarily bringing a difference to the understanding of the subject taught?

RQ2: What type of digital media support (**ICT**s / **DLO**s) could support teaching and practice in capturing data for the production of visual effects where there is integration between real and virtual images (match-moving)?

RQ3: Is the availability of **DLO** in repositories sufficient for its dissemination and possible use by teachers and students?

<u>Specific questions</u>

RQ4: What is the pedagogical and technical validity of the proposed learning object for undergraduate students related to audiovisual production?

RQ5: What features of the tool can be improved for future versions?

RQ6: Is the use of the tool (**DLO**) capable of producing a qualitative gain to audiovisual products conceived through practical exercises in the pedagogical context?

Research Goals

<u>Main Goals</u>

RG1: Develop a **DLO** to assist in performing practical exercises for the production of visual effects (**VFX**) in audiovisual (where there is the interaction between real and virtual images - match-moving) **-** (methodological and empirical goal).

RG2: Evaluate the effective pedagogical contribution that the **DLO** offers through research with students in the classroom (undergraduate level), through research forms to collect data about the product concept, its relevance, suitability. Additionally, it will be carried out a blind analysis review to assess possible interference with quality or productivity with the use of the tool - (theoretical and empirical goal).

RG3: Provide benefits to professional teaching practice at an international level, by sharing the prototype (fully functional) in repositories of international learning objects for use by other teachers from any other educational institutions - (methodological and empirical goal).

RG4: To design an application that can also be used outside the educational context, as a tool to aid smaller audiovisual productions with such technical characteristics - (methodological and empirical goal).

Secondary Goals

RG5: Literature review and state of the art on the use of digital media, **ICT**s, and **DLO**s as tools to aid learning - (theoretical goal).

RG6: Understanding of the real novelty in creating such a tool for teaching the production of visual effects with real x virtual interaction (match-moving) - (theoretical and empirical goal).

RG7: Obtain through theoretical and empirical research which attributes can be improved in the tool so that it can better achieve the objectives for which it was designed and acquire the necessary methodological experience for proposing, assisting, and creating new future learning objects - (theoretical, empirical and methodological goal).

1.5. Research proposal and thesis structure

Research proposal

Perform literature review and state of the art analysis on the design and validation of digital learning objects (**DLO**s), using theoretical framework directly related to the theme, as well as complement the literature review using essential elements from the area of Prototype Design that can be applied to that task to be performed, in order to assist it and make it the most complete within these parameters.

Also, perform a literature review that correlates **ICT**s with education, to understand where and how **DLO**s are located within these research terms, in addition to researching and better understanding terms such as blended learning, active learning, where **DLO**s can be located, when they are not designed for exclusive use in distance learning environments (e-learning), but for mixed-use, supporting classroom teaching activities, for example.

After all the basic research to guide the construction of the prototype, register the steps of the development of the prototype, in addition to the difficulties and solutions found during its conception and tests until it was able to be taken to empirical experimentation in an educational environment with the participating students.

After the prototype is finished, carry out the field research with the methodology that will be explained below, in order to collect the data for its analysis and evaluation of the obtained results.

The research, because it involves a Portuguese research institution, and its empirical part has been accomplished in Brazilian territory is classified as international research by Brazilian institutions.

The entities involved are NOVA School of Science and Technology (**FCT**) of the NOVA University of Lisbon (**NOVA**), Portugal, and the Federal University of Paraíba (**UFPB**) in the city of João Pessoa, Brazil.

In addition, because it involved human beings (students of undergraduate courses related to audiovisual production), it needed to be submitted to the Research Ethics Committee (**REC**) and later to the National Research Ethics Council (**NREC**) in Brazil.

The research received the Certificate of Presentation of Ethical Appreciation (**CPEA**) case number: 03763418.6.0000.5188, the research project was assessed, and its methodology and ethical aspects approved for its execution, according to the presented planning.

Thesis structure

To answer the research questions and achieve the desired results, the research was organized as described below.

Chapter I “Introduction” presents the context in which the work is developed, the presentation of the researcher and his motivation for choosing the research topic, the relevance of the research, the research questions and objectives, the way this work is structured, and events and publications related.

Chapter II presents the “Literature Review” and is divided into two main sections, "2.1. Theory and practice of visual effects in higher education courses related to audiovisual production" and "2.2. New technologies in teaching". Each of these main sections with its internal subdivisions.

Chapter III, “Research Methodology”, presents the methodological decisions taken and a synthesis of the main concepts and dimensions of the analysis model that accompanied the development of the research. The planning, construction, and application processes of the various instruments developed and used in this study are also described. Thus, all procedures associated with the use of surveys by forms with students and teachers are described, in addition to the blind analysis carried out based on the final products developed by students during the period of empirical tests.

Chapter IV, “Prototype Development”, begins by explaining which elements were defined as guidelines for the prototype design, in addition to the characteristics (attributes) taken as a reference for its development and validation. The subtopics present the development stages with their limitations, difficulties, and solutions.

Chapter V “Field Research” describes ethical issues involved in the process of carrying out the empirical research, in addition to presenting the planned and available infrastructure for carrying out the activities, in addition to a more detailed explanation of how the proposed exercises were performed according to the methodologic factors previously defined.

Chapter VI “Data Presentation and Analysis”, the procedures followed in the presentation and analysis of data obtained by applying the various data collection instruments are explained. Subsequently, the main results obtained in the empirical research are also presented.

Chapter VII “Conclusions and Perspectives for Future Research” are presented, tracing the relationship between the results obtained and the answer to the research questions posed. A critical reflection is presented regarding the limitations of the work carried out and research directions for future work are suggested.

Format and style

This thesis opted for the use of the **APA** formatting style, however, that style is superseded by the recommendations and indications of the following regulations of The NOVA School of Science and Technology (**FCT**) of the NOVA University of Lisbon (**NOVA**):

- Dispatch (Directorate) No. 23/2011 - Subject: Formatting of dissertation covers.
- Dispatch (Scientific Council) No. 2/2011 - Subject: Rules for Formatting and Presentation of Masters and Doctoral Dissertations.
- Regulation (Rectory) No. 415/2009, published in the Diário da República, 2nd series - No. 202 - October 19, 2009 - Regulation of the Joint Doctoral Program in Digital Media at the University of Porto and Universidade NOVA of Lisbon.
- Order (Rectory) No. 8277/2012, published in the Diário da República, 2nd series - No. 117 - June 19, 2012 - Change in the Curricular Structure of the 3rd cycle of studies leading to the degree of doctor in Digital Media.

1.6. Events and Publications

The results of this research were published and presented at two international events:

- **IFCL 2019** – 2nd International Conference on Future Learning – December 18 to 20, 2019 - University of Barcelona, Spain.
- **ICEduTech 2020** - 7th International Conference on Educational Technologies – February 5 to 7, 2020 - University of São Paulo, Brazil.

The article submitted to the event (**ICFL 2019**) with the title “**Digital Learning Object for Audiovisual Production**”, mainly presents the results obtained by the research, without detailing how the process of developing the tool (**DLO**) was.

To complement, the article submitted to the event (**ICEduTech 2020**) with the title “**Digital Tool for Blended Learning for Teaching Visual Effects**” sought to fill this gap, mainly addressing how the prototype was developed.

The strategy adopted in the publications was to seek recognition and external validation of the research through these international and renowned events in the area.

The article submitted to the **ICFL 2019** event, in addition to being published in the proceedings of the event, was also accepted for publication in the **IJIET** – International Journal of Information and Education Technology **-** IJIET 2020 Vol.10(3): 201-208 ISSN: 2010-3689 DOI: 10.18178/ijiet.2020.10.3.1364 (Maschio & Correia, Digital Learning Object for Audiovisual Production, 2020).

The article submitted to the **ICEduTech 2020** event, in addition to being published in the proceedings of the event, ISBN: 978-989-8533-99-9 DOI: 10.33965/ICEDUTECH2020_202002L013 (Maschio & Correia, Digital Tool for Blended Learning for Teaching Visual Effects, 2020), was selected and received the ***"Outstanding Paper Award"*** from the conference, being invited to publish an extended version in the **IADIS** - International Journal on Computer Science and Information Systems, published in Vol. 15, No. 1, pp. 56-73, ISSN: 1646-3692 (Conception, Prototyping and Evaluation of Digital Tool to Assist in the Teaching of Visual Effects with Match Moving, 2020).

Chapter 2 - LITERATURE REVIEW

This chapter is divided into two sections.

The first section will discuss what is the role of visual effects in audiovisual production and their occurrence in higher education, in addition to presenting fundamental concepts of the integration between real and virtual images to situate the reader with the complexity that the tool seeks to support during teaching tasks on the theme.

The second section will cover the current concepts and definitions of **ICT**s, **LO**, **DLO**, and **BL**. Research related to these terms/themes is also presented to illustrate how the research on the subject is progressing, clarifying the state of the art. At the end of the second section, the focus will be on the literature review related to the design of **DLO**s.

The understanding is that the first section, despite not dealing directly with the domain to which this research is related (relationship of digital media with **ICT**s and **DLO**s), is still relevant for contextualizing the motivations for choosing the type of prototype to be created as a tool to support learning. The other sections, on the other hand, as being more relevant to the field of study, seek to present works to allow to evidence and substantiate the innovative aspects proposed in this context, clarifying the contribution in terms of innovation and current affairs and strengthening critical reflection on the state of the art.

The literature review was carried out by searching for books and academic articles published preferably in scientific journals as well as in proceedings of peer-reviewed events. The search for articles was carried out in the most popular and accessible search systems for scientific articles such as Scopus, Web of Science, ScienceDirect, SciELO, Google Scholar, ProQuest, Microsoft Academic, JSTOR, DOAJ – Directory of Open Access Journals, SSRN – Social Science Research Network, B-on – Biblioteca do conhecimento online.

The most used search terms in the searches were "digital learning object", "digital learning objects", "learning object", "learning objects". These terms have also been combined with the terms "design", "evaluation", and "validation" to research methods of design and conception, production, evaluation, and validation of **DLO**s.

The research was also carried out using the term “blended learning”, however, although one of the three conceptualizations/definitions about the term is related to this research, most of the research that is developed on the theme focus on the scope of other current concepts. This conceptual explanation will be exposed during the chapter, but in summary, research related to the term blended learning was not widely used despite being cited to exemplify these differences and to present some related research.

Such research was carried out both during the preliminary research for the production of the research project presented and approved by the Thesis Accompanying Committee in October 2018, as well as throughout the research execution project, prototype development and more recently seeking to update the review through recent research.

During these various stages of the research, it was sought to apply temporal filters in the search for more recent works (last 4 to 6 years), however, less recent research and works, and highly relevant authors in the area could not be absent.

2.1. Theory and practice of visual effects in higher education courses related to audiovisual production

The literature review begins with the quote from Braga below, in order to agree with the need for contextualization for a better understanding of the project, the efforts to be employed, and the contribution that it aims to achieve.

> The great importance of the contextualization stage is to reflect and add the pedagogical part to the OA that will be conceived. The more associated the school knowledge and the contexts present in the student's life, the more the knowledge will have meaning. Therefore, it is really important to carry out a contextual analysis to develop the pedagogical contextualization of a learning object. Braga 2015 p.58

It is also noteworthy that part of this contextualization and analysis is also found in the section on technical research for the later execution of the prototype.

2.1.1. The importance of visual effects within the universe of audiovisual production

Under what circumstances are visual effects used in audiovisual products?

> There are three reasons to use visual effects in a film: The first is when there is absolutely no practical way to film the scenes described by the script or required by the director. […] The second reason to use visual effects comes to fore when you could do the scene practically, but doing so might place someone's life at risk. […] The third reason arises when it is more cost effective or practical to utilize a visual effect than to film a scene for real, due to issues of scale or location (or both). (VES - Visual Effects Society, 2010, pp. 02-03).

Visual effects are used in audiovisual products to reduce the cost of the productions, reduce the risk to the actors and production team and mainly to give creative freedom, allowing to create scenes impossible to realize without its use. In this way, it can be understood that the use of visual effects allows a greater creative freedom to the filmmakers because without the tool they stay more limited about what it is possible to transpose from the screenplays to the screens.

> As prosumer technology has evolved, the next such production will likely use the latest DSLR, now capable of live preview output, for the same purpose. This, coupled with evolving commercial frame grabber applications, will democratize stop-motion production, making high-end technology accessible to any budget. (VES - Visual Effects Society, 2010, p. 275).

Technological evolution, as we can see in the quote above, is gradually allowing a democratization of the types of audiovisual content produced, as more and more small audiovisual producers are able to acquire equipment, technology, and training, which allow them to perform increasingly elaborate visual effects. Such effects, once more restricted to the few and large visual effects companies, allow these small producers to have greater creative freedom in their productions, in order to create technologically more complex audiovisual products with a smaller budget.

It is important to highlight the difference between visual effects and animation, as can be understood below.

> Visual effects and animation have a lot of similarities and some significant differences. Visual effects are only a part of a film and are used to augment the live action. Animation, however, is its own world. The animation studio has complete control over everything in the scene and creates the entire movie from scratch. (VES - Visual Effects Society, 2010, p. 740).

Both animation and visual effects are nowadays graced with an enormous amount of professional qualification material currently on the internet, such as video lessons, tutorials and discussion forums, which facilitated access to such content, allowing enthusiasts and interested parties to qualify themselves without the dependence of executing a vocational course for this, reducing the costs of this qualification (with negative points too). In addition, the ease of access to software also facilitates and allows more people to enter this labor market that develops every day.

> Innovations and advancements in digital and computer technologies have also made DVE[1] education more accessible and affordable to the public, with the introduction of affordable animation and compositing software plus the availability of dozens of books and online materials on DVE techniques (Muren, 2004). Unfortunately, the increased availability of DVE education has not alleviated the shortage of qualified professionals in the industry. In an effort to determine the cause of this shortcoming, the researchers have identified the demands that the VFX[2] industry has on the education system. (Ng, Lim, Koo, & Ayman, 2009, p. 275).

2.1.2. The importance of teaching visual effects in undergraduate courses (in the audiovisual area)

An undergraduate course with conditions to qualify the student to produce audiovisual content with more elaborate visual effects allows 1) that this future professional can enter in a more competitive way in the labor market after the conclusion of its course; 2) it make it possible to improve the qualification of the labor market by increasing the number of companies capable of producing more complex content, reducing the dependence of specialized firms (many non-national ones); 3) it helps in the democratization of knowledge since many students of public and private universities do not have the financial conditions to carry out private specialized courses in the area; 4) it allows students greater creative freedom to produce their audiovisual projects and portfolios.

It should be noted that currently most of everything that is produced is already from the perspective of going through digital changes and corrections before reaching the final product. In this way, we can say that practically all the content uses visual effects. In this context, increasingly the image is losing credibility, because the excessive use of visual effects makes people no longer see them as documentation of reality, sometimes needing an opinion from a specialist in digital manipulation, before attesting if one image is credible.

However, it is worth emphasizing the importance of visual effects and their fictional universes for the evolution of society. Two clear examples are the use of computer graphics films for the teaching of contents that are difficult to assimilate because of the abstraction that content requires, such as

[1] DVE means Digital Visual Effects
[2] VFX means Visual Effects

physical explanations of relativity theory, black holes, principles of thermodynamics, human physiology, that is, it is possible through virtual images to explain today micro and macro phenomena in a more intelligible way (besides the possible simulations). A second example is how much the world of fiction also inspires young people who over time become mature scientists and researchers and have in fiction works the inspiration to create products such as mobile phones with audio and video chat, flat screens, body controls, flying cars, autonomous cars, virtual realities, lasers, bionic organs, wireless devices, among many other examples of products that appeared much earlier on the screen than in the tangible world.

2.1.3. Teaching practice in undergraduate courses (higher education)

In Brazil, several teachers do not have the pedagogical training to work in higher education.

> Isaia, Maciel, Bolzan (2010), affirms that it is not a common reality in Brazil to have undergraduate courses that form teachers for Higher Education; Generally, the undergraduate courses mold teachers for Basic Education, the baccalaureate courses mold professionals for different fields and the postgraduate courses are mainly research-oriented. It is necessary for the teacher the specific knowledge of the subject area and the ways of constructing pedagogical strategies to develop the necessary study activities, which will be fundamental elements in the process of building up as a teacher and learning the teaching (Isaia e Bolzan, 2006; Isaia e Bolzan, 2007a, 2007b). Especially when this teacher did not have formal preparation for teaching. (Schlemmer, Roveda, & Isaia, 2016, p. 235).

As mentioned, university professors in Brazil sometimes do not have a pedagogical basis for their practice; moreover, in many cases, they begin their career in teaching after graduating from undergraduate and postgraduate courses, without any direct exercise of their knowledge in the labor market, together with companies in the area.

> we found teaching faculty members with didactic training obtained in undergraduate courses; Others, who bring their professional experience into the classroom; And, still others, without professional or didactic experience, coming from a course of specialization and/or stricto sensu. The defining factor of teacher selection until then was scientific competence. (Morosini, 2000, p. 11).

In this way, many professors at the Brazilian universities do not have the practical experience of knowing how to do in the context of the marketplace actuation. That is, they have deep knowledge, critical and reflective base in the area of performance, but not always within the context of the problems that exist in the professional activity outside the academy. Other aspects (such as organizational, administrative, ethical, among others) are sometimes outside of their reflections, criticisms, and teachings.

> The competence can only be established in practice. It is not only knowing but knowing how to do it. One learns by doing, in a situation that requires this determined", so the students end up identifying themselves since in addition to the teacher seek the development of the learners' competencies, he contextualizes and teaches where to apply it. (Teixeira, 2008, p. 1 as cited in Schlemmer, Roveda, & Isaia, 2016, p. 235).

This scenario reveals the existence of the prevalence of teachers with higher theoretical, reflexive, and critical training, but without the same degree of practical market experience. This teacher profile leads to a certain profile of egress, also more critical and reflexive about his professional practice, but without an experiential base that helps him in his practice (leaving to the job market and to external courses this task).

Despite the Brazilian Guidelines and Law of National Education (**LDB** nº 9.394/dez/96), in its article 66, to clarify that "The preparation for the exercise of the higher teaching profession will be done at postgraduate level, mainly in master and doctoral programs" Vasconcelos (1996, p. 5) states that the teacher must be committed "[...] to educational issues in a much broader sense than the mere transmission of knowledge or professional experience."

That is, it is necessary the attention to a learning and pedagogical orientation next to the practice and experience of the professional because when combined with the theory in a pedagogical context can be much more effective.

> Another source that constituted the knowledge of teachers quoted was a professional experience. In it, the beginning teachers sought the examples and cases that allowed to relate the theory to the practice. For many, without the practical experience, it would not be possible to teach the content and achieve the objectives of the discipline [...] (Engel & Volpato, 2016, p. 272).

With this concern in favor of higher education based on pedagogy, theoretical reflection and practical experience is where this doctoral project is located, using new technologies (**ICT**s) in designing and validating a learning object for use in the classroom. The proponent follows the thought of Cardoso below.

> Teaching in Higher Education requires a complex background that includes knowledge of the experience (practices and experiences), specific knowledge of the content that teaches, theoretical and pedagogical knowledge (teaching methodology). In addition to the new competence to be part of this role, the knowledge for the use of Information and Communication Technologies – ICTs in the teaching processes, which includes both instrumental knowledge and specific knowledge for the integration of ICTs (Cardoso, 2016, p. 102).

2.1.4. Investments and infrastructure in Brazilian federal universities

It is not possible to only address to teachers the responsibility for the egress profile in an undergraduate course. The composition of the curriculum of these students, the number of disciplines, the didactic methodology to be adopted by the group of teachers, the pedagogical political projects, interdisciplinary and transdisciplinary methods are all constituted by the collective formed by both the teachers and the administration of the universities and colleges which will provide adequate infrastructure regarding the goals of the course.

Examples of this infrastructure can be libraries, databases for research, equipment, classrooms, laboratories with adequate computers, licenses for the necessary software, technicians for the management and maintenance of these spaces, air conditioning, audio and video recording studios, equipment insurance. This entire infrastructure allows greater or less success in the search for an ideal educational purpose.

In this context, it is important to highlight that, without equipment, infrastructure, qualified personnel (teachers and technicians), it is difficult to attempt any practical exercises in undergraduate courses, whether in the audiovisual area or in a medical, engineering or any other. One can imagine medicine or physiotherapy without an anatomy laboratory; Engineering, without laboratories for mechanical, electrical, magnetic, and material testing; Finally, audiovisual without cameras, audio recorders, microphones, studio, editing and postproduction stations, or lighting equipment. If there is only theory, it is only possible to provide a theoretical course.

To contextualize the Brazilian reality is depicted in the journalistic quote below.

> The federal government plans to cut up to 45% of the resources expected to invest in federal universities in 2017, compared to this year's budget. Already the estimated amount for costing should have a drop of about 18%. According to calculations by managers, will be about R$ 350 million less in investments for the 63 federal universities - in comparison with the R$ 900 million forecast for the sector this year. Institutions are already experiencing a serious financial crisis, with reduction of programs, contracts and even difficulties to pay bills. [...] Federal universities had cuts since the end of 2014 and suffer from high inflation - 8.7% in the last 12 months, according to the Broad National Consumer Price Index (IPCA). The restriction of investment money - for works, renovations and equipment purchases - signals difficulties to improve or expand the infrastructure. (O Estado de São Paulo, 2016).

In April 2019 new cuts occurred.

> At the end of April, the Ministry of Education (MEC) blocked part of the budget of 63 universities and 38 federal educational institutes. The cut, according to the government, was applied to non-mandatory expenses, such as water, electricity, outsourced workers, works, equipment, and research. Mandatory expenses, such as payment of salaries and pensions, were not affected.
> In total, considering all universities, the cut is R$ 1.7 billion, representing 24.84% of non-mandatory spending (called discretionary) and 3.43% of the total federal budget. (Tenente & Figueiredo, 2019).

And most recently in 2020.

> In his newest affront to higher education, President Jair Bolsonaro sanctioned the cut of R$ 19.8 billion for the sector. At Federal Universities, the budget reduction will be R$ 7.3 billion (14%), which will result in new challenges for teachers and students of Public Education in Brazil. (...) Of this total of cuts, 73% (R$ 14.7 billion) will directly impact personnel expenses, which includes the payment of university employees and professors. While in 2019 the amount paid for personnel and social charges was R$ 73 billion, this year, the forecast is that it will not exceed R$ 58 billion, that is, 20% less. (APUFPR - Associação dos Professores da UFPR, 2020).

This reality unfortunately already means that public education institutions cannot count on a regular budget, which already makes it impossible to maintain and manage existing resources. Moreover, its further compromises more ambitious investment plans, so that teachers and managers themselves cannot plan, acquire and maintain the minimum conditions desired by specialists in their area, and must always juggle to provide the best possible education conditions.

A direct reflection of this political and cultural situations are the university curricula, which tend to be proposed to depend less on resources, with little experimentation about future professional practice, since the books or electronic documents are cheaper than laboratories (leaving the responsibility of teaching the practice to the labor market that will welcome these future professionals).

2.1.5. Teaching visual effects in audiovisual production courses

Because it is a more complex production, it requires greater theoretical, practical, technical, and technological knowledge for teaching and experimentation. Thus, if there is no collective effort by a number of faculty members to prepare the student to gather the necessary knowledge gradually, it becomes difficult to teach this type of more complex products in the short time of the learning process of these students.

At the same time, there is a line of thought among some teachers that the main task of undergraduate courses is to offer training and basic assumptions, the essence of knowledge, due to the impossibility of preparing a university student to leave the university fully competent in theoretical and practical knowledge. These understand that only the professional practice itself allows the learning experience of subjects such as ethics, interpersonal relations, commitment, responsibility, characteristics that for some teachers should already be clear to students through their own moral education and family ethics. The university education would offer deepening and reflection, rather than becoming a starting point for these themes.

This project has as perspective the importance of the teaching of complex productions in audiovisual in the undergraduate courses. However, knowing the ideological and budgetary limitations presented, it is understood that it is sometimes impossible to teach and practice very elaborate visual effects. For this reason, the teaching of the basic concepts of integration between real and virtual elements is marginally offered in undergraduate courses related to audiovisual production in Brazil.

2.1.6.Basic concepts for real and virtual integration

This research project seeks to create a learning object for the teaching of theoretical and practical foundations to produce visual effects that integrate real images with virtual images.

When it is not required that this kind of integration to be imperceptible, the integration process could be less rigorous, however, when there is a need for perfect integration and verisimilitude, these concepts are more demanding and should be more rigorous. “While some animation will adhere to photorealistic principles in terms of the behavior of light, reflection, and other material characteristics, an animated film will often make intentional variations away from pure realism for creative impact” (VES - Visual Effects Society, 2010, pp. 742-743).

Considering, therefore, the most demanding production situations, these concepts will be based on the production of integrated audiovisual contents blending what was captured by the camera and what was digitally generated by computer graphics programs.

To meet these characteristics, the importance of respecting the physical and tangible realities (laws) of human knowledge for the representation and creation of virtual fictional realities becomes essential for their verisimilitude. That is, as we relate to totally fictional stories of non-human universes, without Earthlings, any relation to the concepts of the sciences we know (physics, chemistry, biology, etc.) makes possible a better acceptance by the public with this kind of fantasy reality.

In addition to this more relevant observation regarding the script, we have the basic theoretical and technical questions that allow a good integration between real and virtual images, which help in the illusion of three-dimensionality of the images and in the perfect union of these. They are perspective; occlusion; texture gradient; optical distortion; reflection; and various factors related to lighting, where we consider light and shadow.

> […] the image must be analyzed to identify depth cues to help determine the shape and depth of the original image. The human visual system derives perceived depth using both physiological

> and psychological cues. Retinal image size, linear perspective, texture gradient, overlapping, motion parallax, aerial perspective, shading, and shadows can all be used to help determine the depth of an image and the shape of an object. Individually, each cue provides an indication to the original depth and shape of an object. Identifying as many cues as possible will provide a more accurate representation of the original image depth. (VES - Visual Effects Society, 2010, p. 414).

> […] matching the light in plates is truly essential to creating an effective illusion in the finished composite. In fact, when the background plate is being created in a 3D program, it is probably a good idea to also draw up a basic lighting diagram that will be used for both the fictional background world and the real-world greenscreen studio. (Jackman J. , 2012, p. 103).

The quote above reflects the essential importance of seeking to reproduce the same illumination in the actual filming environment and in the virtual environment. The perfect integration of lighting (light and shadow) is one of the most difficult factors to plan and execute in integration between real and virtual images.

> While shooting, the Director of Photography (DP) will have made many decisions about how the film is to be lit and photographed to determine what emotional effect the lighting should have on the audience. In many cases the job of the digital lighting artist working on photographed plates is to mimic the on-set lighting as perfectly as possible by either using on-set lighting data directly or by placing CG lights within the scene to match the on-set lighting rig. It is clear that in order for digital lighting artists to be able to perform this task, they need excellent reference photography of the lighting conditions on set. Such reference allows the confident placement, coloration, and intensity adjustment of lights to ensure a precise match with the plate. (VES - Visual Effects Society, 2010, p. 656).

Concepts about perspective, occlusion, texture gradient, optical distortion, and reflection are relatively easier to understand and convey. However, the existing variables in the lighting issue are so complex that it often takes a great deal of effort in the tasks and practical exercises for the correct assimilation by students.

> Monocular, static depth cues refer to depth information that can be inferred from a static image viewed by a single eye. Because they can be seen in a still picture, static cues are also called pictorial cues. These cues include relative size, height relative to the horizon, occlusion, linear and aerial perspective, shadows and lighting, and texture gradients. (Bowman, Kruijff, LaViola Jr., & Poupyrev, 2004, p. 60).

With regard to light, the students have to understand and take notes about at least: The quantity; Its origin (natural or artificial); The color (temperature); Their angle of incidence; Type (hard or diffuse); Quality (tungsten vapor, mercury, sodium, etc.); Area of existence (point, cylinder, panel). Regarding the shadow generated by light(s), it is necessary to pay attention to its quantity; Type (diffuse or hard); Angle of incidence.

> These issues apply just as much in the virtual world as they do in the real world. Essential elements of lighting that must match between the background and foreground plates are:
> 1. The quality of light. Is the key a hard-light source or diffused? How large is the key source? How close is it to the subject? […] 2. Position and intensity of key light. […] 3. Position and intensity of fill light. […] 4. The intensity of the fill light, particularly in relation to the key, determines the contrast of the picture. (Jackman J. , 2012, p. 111).

The great lesson to be conveyed and assimilated by students in theoretical and practical terms (with the help of the learning object to be designed and validated) is that "Lighting in 3D graphics software follows the same principles of real-world lighting" (VES - Visual Effects Society, 2010, p. 698) and for this reason, it is necessary to reproduce the same conditions of illumination in all the elements that are sought to realize a correct composition including real and virtual images.

Difficulties in applying concepts during the execution of practical exercises

Although several factors are relevant to the pedagogical practice of teaching visual effects production where there is an interaction between real and virtual images, next Table 2.1 was drawn up with a summary of the challenges and responsibilities of the process.

With the help of this table, it is possible to observe that the most difficult item that falls on the student (responsibility for the condition) is item 4, which relates the diversity of knowledge that needs to be associated to achieve the final objective.

In this step, not only this association of different knowledge and concepts is necessary, but also essential for the elaboration of references and collection of reference data during the recording of the real images. The digital learning object will be conceived to assist in this practical stage of teaching and production.

Table 2.1 - Item difficulty x Responsibility for the condition

Item difficulty	**Responsibility for the condition**
1 - Diversity of competencies involved required: - Image capture by device - theoretical and technical knowledge in the use of image acquisition equipment. - Lighting - theoretical and technical knowledge in the use of lighting equipment. - Electrical - basic theoretical and technical knowledge required for safety reasons. - 3D software - basic theoretical and technical knowledge of modeling, texturing, mapping, lighting, rendering and three-dimensional animation. - Composition software - basic theoretical and technical knowledge of video composition, layers, masks, etc.	• Political pedagogical project of graduation course (teachers, institutions representative of the area, government policies). • **Student**: Commitment and interest during learning.
2 - Balance of theoretical and technical knowledge among students for better pedagogical progress.	• Political pedagogical project of graduation course (teachers, institutions representative of the area, government policies). • Pedagogical policy for better homogeneity of knowledge among participants. Example: discipline(s) as a prerequisite. • Teacher: attempt to accomplish some leveling between the students' knowledge.
3 - Infrastructure for the execution of pedagogical practices: - Adequate space. - Electrical installation, acoustics. - Varied equipment for pre-production, production, and post-production. - Reference objects for the posterior production of three-dimensional content.	• Educational institution.

- Adequate time of use of the previous items according to the pedagogical proposal. - The assistance of technicians for the execution of the activities.	
4 - A large amount of information needed to be produced and collected during the recording of the actual images for later reproduction and adaptation of the virtual images to the real ones.	• Teacher: prior teaching of variants and basic needs. • **Student**: knowledge acquired, organization and methodology not to forget to collect relevant data.
5 - Analysis of the experiments (executed exercises) and feedback by students and teacher. - Time needed for analysis, discussion, reflection and devolution by the teacher and students about the content taught.	• Teacher: duration of the course and control of the execution. • Student: interest and proactivity in reflections and devolution after experiments.

The degree of difficulty of execution of this item 4 resides in forgetting to collect vital information that can make the audiovisual project unfeasible (which intends to interact with real and virtual images with verisimilar aesthetic quality).

If these data are not correctly measured at the time of scene recording, the lack of information may in the worst-case scenario completely compromise the product execution. The scenes with camera movement are of more complex execution, depending more on such information since the scenes without camera movement can even be executed with a lower collection of data. However, this leads to execution by trial and error instead of a more methodological approach and consequently more efficient, agile and consequently with lower costs.

As a pragmatic consequence, more time will be required to complete the project, which is reflected in higher costs due to the use of the equipment and skilled labor. In the classroom context, perhaps the time planned for the exercise may not be enough.

Being this item 4 one of the determinants for the success of the practical teaching activity under the responsibility of the student, this work proposes to create a digital tool (software) to be used as a learning object, that is, a facilitator of the teaching process in this type of teaching practice.

The hypothesis of this thesis is that with the help of digital media it will be possible to have a qualitative gain in the transmission of the contents in question and in the execution of this type of pedagogical exercise. The research will also seek to gauge indications for the improvement of the designed learning tool.

Previous work related to the production of visual effects served as the basis for this research and technical development of this prototype. However, as the research does not have as main object theories and techniques related to the production of visual effects itself, but the construction of a learning object that will support the teaching of this type of content, it was understood as adequate not to extend too much the technical discussions related to the production of visual effects.

It was decided, therefore, to present only the main concepts, to understand the context of the project in execution and the variants and complexity existing in the content that the tool will aim to support. Nevertheless, it is important to register here the relevance of some works in the area as The Visual Effects Producer: Understanding the Art and Business of VFX (Finance & Zwerman, 2009), Matchmoving: The Invisible Art of Camera Tracking (Dobbert T. , 2005), The Art and Technique of Matchmoving: Solutions for the VFX Artist (Hornung E. , 2010), The Filmmaker's Guide to Visual Effects:

The Art and Techniques of VFX for Directors, Producers, Editors and Cinematographers (Dinur, 2017) and Filming the Fantastic: A Guide to Visual Effects Cinematography (Sawicki, 2007).

2.2. New technologies in teaching

In this section, the bibliographic review related to the concepts and definitions that articulate the technological evolution in teaching will be presented. The concepts and definitions related to this research will be scored, as well as a presentation of the state of the art of research in the area, as well as references for the design and production of learning objects.

2.2.1. Concepts and Definitions

The new technologies are becoming more and more a part of the daily life and the area of education is one of those that is also undergoing transformations due to technological advances. Currently, several types of research are carried out to study how technology can and is being included in teaching and which of these forms can actually bring some kind of pedagogical contribution or are only a distraction that does not contribute to the learning process.

> […] the introduction of new forms of media to the classroom—whether they consist of charts and diagrams, textbooks, films, or various media accessed through computers—has not only changed the process of teaching and learning, but also directly affected schools themselves as state institutions. The implementation of these media is regulated by the state in order to enforce its educational monopoly within the classroom and to control the nature of knowledge. At the same time, the implementation of these media provokes intense debate among educators, who dispute the extent to which the new media improve the quality of teaching and learning or even harm children. (Fuchs, Bruch, & Annegarn-Gläß, 2016, pp. 9-10).

One of the current trends and motivating factors of contemporary education is the implementation and use of information and communication technologies (**ICT**) in the educational process.

> Today, the teachers approach to use ICT is more positive. From the perspective of a teacher this means a new way of teaching and from the perspective of a student a new way of learning. Learning through ICT becomes more interesting to students especially. Also building of interdisciplinary relations and merging of various literacy automatically arises. Computers, educational software, digital learning objects, mobile devices and interactive whiteboards also develop student creativity. (Bártek & Nocar, Digital learning objects as a support for new teaching methods, 2016, p. 2583).

In this way, it becomes evident the need for the development and improvement of digital media **ICT** tools, as defended by Kobs and Casagrande Jr. "[...] **ICT**s can contribute to education increasing the students involvement with learning objects from the use of smartphones and other technological instruments, both at school as out of it." (Kobs & Casagrande Jr., 2016, p. 56).

According to López-Pérez et al. (Blended learning in higher education: Students' perceptions and their relation to outcomes, 2011) "New information and communication technologies (ICTs) provide educators and learners with an innovative learning environment to stimulate and enhance the teaching and learning process." (López-Pérez, Pérez-López, & Rodríguez-Ariza, 2011, p. 818).

Muspratt and Freebody in (Students' perceptions of the characteristics of "good" and "poor" digital learning objects, 2007) present the position below on the use of **ICT**s in education, contributing to a certain extent even to highlight and justify the contribution that this research has to offer in the field of study.

> Increasing investments in ICT by educational systems around the world over the last decade have been accompanied by a growing body of research attempting to evaluate the efficacy of these investments and to explore how to use ICT more creatively and effectively for learning and teaching. The authors of many of these reports share a concern that the effort and expenditure in making ICT available to school systems is not reflected in the uptake and creative use of ICT in educational settings (see for instance, Jamieson-Proctor, Burnett, Finger & Watson, 2006; Smeets, 2005; Nichol & Watson, 2003). (Muspratt & Freebody, 2007, p. 2)

Tedesco is a supporter of the thought that “the incorporation of new technologies in education should be considered part of a global educational policy strategy” (Tedesco, 2008).

Another relevant concept is the concept of Open Educational Resource (**OER**), which can be defined as "the content licensed in order to offer users the right to make more varied uses than those permitted by law, and at no cost" (Wiley D. , 2020). The permissions or rights to use open content can be represented by four main characteristics: Reuse, Reissue, Remix and Redistribute. Open content is therefore what allows these four possibilities.

> In 2020, UNESCO adopted the term Open Educational Resource and defined it as" digitalized materials offered freely and openly for use and reuse in teaching, learning and research (UNESCO, 2018)

This term will not be adopted in this thesis because the Digital Learning Object to be produced in this investigation will unfortunately not meet all these prerogatives, and it cannot conceptually fit as an **OER**, despite having its open code and available to interested parties to use it as a basis for design to other similar tools.

According to the Critical Dictionary of Education and Technologies and Distance Education (Mill, 2018)**,** the term learning object (**LO**) was coined by Wayne Hodgins in 1994 and had its conceptual roots in the field of computing, more specifically, in reuse literature, from object-oriented programming. However, “The roots in education made this expression very technical and far from its application in the educational context, having generated problems of interpretation, in addition to several criticisms (Freisen 2004).” (Mill, 2018, p. 481)**.**

However, it presents consensual information in the area, that “The definitions found are innumerable and often divergent”. (Mill, 2018, p. 481)**.**

Another definition of learning objects is extracted from the work of Cavalcante et al. (Uma proposta de objeto digital de aprendizagem para o ensino de ondas sonoras, 2019) next.

> Learning objects (OA) are presented as important tools that can assist the teaching-learning process. These resources are inserted within a Digital Culture that aims to explore the didactic-pedagogical character in the use of available technologies for the development of competences inserted in the scope of the development of tools that assist the teaching and learning of students. (Cavalcante, Moreira, & Sales, 2019).

Another statement by Muspratt and Freebody that in a way also clarifies the contribution of this research is that of the following sentence “There has been little empirical research of the educational effectiveness of LOs, and the results from the few studies that have been conducted are equivocal.” (Muspratt & Freebody, 2007, p. 4).

Another important quote from the same authors that also qualifies and justifies the innovative aspects proposed in this context is found below.

> Just as there is a scarcity of empirical studies investigating the effectiveness of LOs, there is also a scarcity of studies investigating teachers' attitudes towards and perceptions of the LOs they use in their classrooms. The only two studies we are aware of are survey and observational studies conducted as part of the evaluations of the TLF and CELEBRATE initiatives. The findings from the two studies are similar. On the whole, teachers' reactions to using the LOs are positive. Teachers use the LOs in a variety of contexts, and take the view that students enjoy working with the LOs, that the LOs increase students' motivation and persistence with learning tasks, and that they help students to learn (McCormick & Li, 2006; Freebody, 2005, 2006; Freebody, Muspratt & McCrae, 2007, in press). (Muspratt & Freebody, 2007, p. 5).

Machado (Measurement of Resources and Investments to Develop Digital Learning Objects, 2008) says “Learning objects are components that, separately or in set with others, form a specific material that will be used in the learning process, being able to be reused in diverse structures.” (Machado, Augusto, Marcelino, & Mustaro, 2008, p. 340)**.**

Akpinar (Different Modes of Digital Learning Object Use in School Settings: Do We Design for Individual or Collaborative Learning?, 2014) comments that “The LO approach became popular due to its features such as interoperability, durability, scalability, adaptability, reusability, flexibility and cost-effectiveness.” (Akpinar, 2014, p. 88)**.**

There are currently several concepts and definitions about learning objects, such as Sosteric and Hesemeler, “A learning object is a file (image, movie, etc.) that is intended to be used for educational purposes and has, internally or through associations, suggestions on the appropriate context for its use” as cited in (Ghisi, 2016, p. 632).

Some authors define learning objects as any resources used to aid learning. Others define them as a digital resource used for educational purposes. “Any digital resource that can be reused to assist learning” (Wiley D. A., 2000, p. 7). Its definition includes any digital resource that can be distributed over the network, on demand, be it small or large.

> Educational objects can be defined as any resource, supplementary to the learning process, which can be reused to support learning. The term learning object generally applies to educational materials designed and constructed in small sets in order to maximize learning situations where the resource can be used. (Tarouco, Fabre, & Tamusiunas, 2003, p. 2).

Likewise, the digital learning term can be understood as “Use of digital technology to support learning. This term is context free to specific digital technology, environment, pedagogy, instructional design, and learner interaction with the material or environment.” (Basham, Hall, Carter Jr., & Stahl, 2016, p. 127).

> New generation classrooms and neither alone digital technology are not possible to imagine in education without educational content. These contents are different forms of digital learning objects (DLO), respectively specific software for their creating and distribution. New Media Consortium (NMC) defines digital learning objects as a group of materials (texts, hypertexts, graphics, pictures, simulations, films, sounds, etc.) which is reasonably structured and is based

> on educational aims and objectives ([8], [9]). It is multimedia content, educational content, educational software or software instruments used in computer supported education ([10]). DLO can be understood as a category of multimedia learning aids. Dostál ([11]) defines multimedia learning aid as "a digital tool integrating various forms of documents and data (e.g. texts, tables, animations, pictures, sounds, video, etc.), which present and copy the reality to help and simplify the education." (Nocar, Tang, & Bártek, 2016, p. 3477).

According to Braga (2014, p. 21) the Institute of Electrical and Electronic Engineers (**IEEE**), created in 1884 with the mission of fostering technological innovation and excellence for the benefit of mankind, has a Committee for Standards for Technology, the **IEEE** Learning Technology Standards Committee (**LTSC**), which has the task of developing technical standards, best practices, and guides for internationally re-taught learning technologies. This committee "defined a **learning object** as: 'Any entity, digital or not, that can be used, re-used or referenced during technology-supported learning. ' " (Braga, 2014, p. 21).

Becker, B.W. then discusses what Digital Learning Objects (**DLO**s) are, in addition to presenting some reasons for their adoption and use.

> Designed to address many different topics and subject areas, digital learning objects (DLOs) have been popular for the past several years. More dynamic and interactive than traditional tutorials, DLOs typically contain a variety of media such as video, audio, and photos. DLOs are reusable Web-developed applications that can be self-contained (meaning that they require minimal support from other computer applications or programs). (Becker, 2010, p. 86)
>
> With budgets being cut and information literacy instruction needing a new approach, now is an ideal time to begin introducing DLOs into library curriculum. This dynamic, free, and reusable material is quickly becoming a regular addition to the academic experience. (Becker, 2010, p. 88)

This project will use the software as a learning object, a valid option according to Braga. "Many applications can be used to support learning in a direct way and, therefore, can be considered learning objects. " (Braga, 2014, p. 25).

Harman and Koohang's article provides a brief theoretical review of **DLO** (Discussion Board: A Learning Object, 2020) and it is possible access a historical review of Learning Objects (**LO**) from their initial analog conception can be found in work published by the MIT Media Laboratory by Zucherman (Historical Overview and Classification of Traditional and Digital Learning Objects, 2006).

Another important concept/definition relevant in the area for research is that of Blended Learning (**BL**). According to a recent publication by Picciano "Without a clear definition, blended learning is perceived as some nebulous combination of online and face-to-face instruction." (Picciano, Blending with Purpose: The Multimodal Model., 2019, p. 8). In another publication by the same author, also recent, he defines **BL** as "In the broadest sense, blended learning can be defined or conceptualized as a wide variety of technology/media integrated with conventional, face-to-face classroom activities." (Picciano, Blended Learning: Implications for Growth and Access, 2019). This second definition/conceptualization is the most consistent to fit this research within this terminology.

According to López-Pérez et al. in the following quote.

> The current trend to complement face-to face (FTF) classes with web-based materials is known as "blended learning" (Garrison & Kanuka, 2004). This style of learning is normally defined as

> the integration of traditional classroom methods with online activities (termed “e-learning”) (Garrison & Kanuka, 2004; Graham, 2006; Macdonald, 2008). According to the Centre for Educational Research and Innovation (CERI, 2005), blended learning courses are becoming increasingly significant, with ICTs being developed to complement, not replace, traditional forms of learning (Mitchell & Forer, 2010: 78). (López-Pérez, Pérez-López, & Rodríguez-Ariza, 2011, p. 818)

According to the dictionary organized by Daniel Mill (Dicionário crítico de educação e tecnologias e de educação a distância, 2018), the term **BL** emerged as one of the most popular pedagogical concepts of the beginning of the 21st century and would have been used, for the first time, in 2000, in an Idea Data Center document entitled E-learning in practice, blended solutions in action (Anderson 2000). According to Mill's work.

> The term appears when the author, after studying the alternatives for the creation and development of a training course, suggests that the best alternative would be a blended solution, obtained by mixing and articulating face-to-face teaching. and distance learning. In effect, initially, the term blended learning was used in this sense, as the connection between the classroom and distance learning (e-learning), mediated by the computer (Graham 2006). (Mill, 2018, p. 86).

However, more recently, due to the growth and expansion of the internet and online tools, more than integrating face-to-face and non-face-to-face moments, blended learning “asserts itself as a concept of education characterized by the use of combined or mixed solutions, involving the interaction between face-to-face and distance modalities, the interaction between pedagogical approaches and the interaction between technological resources” (Mill, 2018, p. 86).

That is, the use and interaction of different technological resources for teaching is also considered as one of the accepted definitions as a conceptualization of **BL**, and can also be used to refer to this research, which aims to build a **DLO** for use during traditional classroom activities to support learning.

Another quote that has a close correlation with this research project is presented below.

> Currently, the development of mobile devices, such as smartphones and tablets, has sparked interest in so-called mobile learning (or m-learning). Pursuing this technological development, it is common for these mobile devices to appear at school to promote a more flexible approach to learning. (Mill, 2018, p. 87).

This quote has a total dialogue with this research because the prototype to be developed has the intention of being able to be used both on computers and on mobile devices, in order to become a tool accessible to students in any shooting environment.

Another important quote contained in Mill's work is a brief review of current trends in blended learning that identifies educational advantages at different levels.

> 1) impact on students' academic performance, particularly with regard to reducing drop-out rates and better school performance; 2) student motivation and satisfaction, due to collaborative and cooperative learning; 3) ease of access and flexibility in learning; 4) cost-benefit of the course; 5) more active learning when compared to the classroom and/or distance learning courses (Garrison e Vaughan 2008). (Mill, 2018, p. 88).

Some examples of works related to the term Blended Learning will be presented later in the presentation of the state of the art, however less when compared to research related to the term Digital

Learning Object, because despite the possible framing of this research in the concept of blended learning, most research using the term **BL** is related to the conceptual line related to the mix between traditional teaching and e-learning.

Still, in relation to the concept of Blended Learning, the quote below is relevant to highlight the framing of this research also through this terminology.

> What is being blended? One frequent question asked when one hears about blended learning (BL) is “What is being blended?” While there are a wide variety of responses to this question (Driscoll, 2002), most of the definitions are just variations of a few common themes. The three most commonly mentioned definitions documented by Graham, Allen, and Ure (2003) are:
> 1) BL = combining instructional modalities (or delivery media) (Bersin & Associates, 2003; Orey, 2002a, 2002b; Singh & Reed, 2001; Thomson, 2002)
> 2) BL = combining instructional methods (Driscoll, 2002; House, 2002; Rossett, 2002)
> 3) BL = combining online and face-to-face instruction (Reay, 2001; Rooney, 2003; Sands, 2002; Ward & LaBranche, 2003; Young, 2002)
> The first two positions above reflect the debate on the influences of media versus method on learning (Clark, 1983, 1994a, 1994b; Kozma, 1991, 1994). Both of these positions suffer from the problem that they define BL so broadly that there encompass virtually all learning systems. One would be hard pressed to find any learning system that did not involve multiple instructional methods and multiple delivery media. So defining BL in either of these two ways waters down the definition and really does not get at the essence of what blended learning is and why the concept of blended learning is exciting to so many people. The third position more accurately reflects the historical emergence of blended learning systems and is the foundation of the author’s working definition. (Graham, Blended Learning Systems: Definition, Current Trends, and Future Directions, 2005)

It becomes possible, therefore, to identify the possible conceptual framework of this research as **BL**. However, as also explained in the excerpt presented, **BL** has other meanings. In this way and for this reason, this literature review will focus more on research related to the term **DLO** and will only briefly illustrate some research using the terminology **BL**.

The following will present some studies in the area to better situate the state of the art of research related to Digital Learning Objects and Blended Learning.

2.2.2. State to Art

The research by Muspratt and Freebody (Students' perceptions of the characteristics of "good" and "poor" digital learning objects, 2007) due to its breadth is interesting that deserves to be scored. The researchers carried out the research in the following setting.

> Sixteen Year 6 classrooms from fifteen schools located in Victoria participated in the study. Thirteen schools were located in Melbourne (inner city and suburban schools), one school was located in a regional center, and one school was located in a rural area. The sample included two Catholic schools and one independent girls’ school (…) A total of 365 students from these classrooms took part in the study, although not all students contributed to all components of the study. (Muspratt & Freebody, 2007, p. 7).

The research finally reports an analysis of interviews with 300 students about their interactions with a total of 30 learning objects and sought an evaluation by students about these **LO**s if they were considered “good” or “bad”. The intention has value both for developers of online content, as well as for teachers who need to choose which digital content to use in their teaching practices.

The work highlights the efforts of education authorities in Australia and New Zealand to create online curricula with content in priority areas of the curriculum and to make this content available to all educational authorities. The Le@rning Federation (TLF) revealed that until that moment (2007) "TLF, now in its fifth year of operation, has more than 3000 LOs available for use in Australian and New Zealand schools" (Muspratt & Freebody, 2007, p. 2)**.** In addition, they comment on similar national and international initiatives aimed at building large **LO**s repositories such as the CELEBRATE in Europe, Curriculum Online in the UK, eduSource in Canada, and the National Science Digital Library in the US.

As interesting conclusion of the study, they realized that as current students already grow up with routine use of digital media, they do not see them as tools like the older generations (teachers), but as possible means where facilitation, interaction, and engagement can occur. As suggestions for improvement, the indication was that **LO**s allow interaction with students, more control over the progression process, something more like games, and less with conventional classroom activities. The students clearly distinguished the **LO**s between good and bad based on these characteristics. However, it is worth considering an important observation of the study transcribed below.

> But it is not up to the developers only to meet students' expectations for interaction and engagement; teachers too have a role to play. They need to incorporate LOs into classroom practices in a way that disperses the spaces for interaction and engagement into the surrounding environment. In this way, the participation structures of that surrounding environment itself can be reshaped by an understanding of the potential affordances of ICT-based learning. (Muspratt & Freebody, 2007, p. 16)**.**

In other words, commitment from teachers and the institution itself is necessary to create a favorable environment for students to engage and interact with the teacher and the content, as only the **LO**s are not sufficient and responsible for fulfilling these roles. In addition, not everything that students believe to be the best for **LO**s necessarily is, as simple gamification is not enough to qualify a **LO**s as good if it doesn't meet its pedagogical goals and be supervised and measured by the teacher.

Another example of the use of recent **DLO** is the action research project developed with undergraduate business administration students at University Colege Dublin, Ireland, with analysis through the development of a set of short videos in order to assist students in understanding statistical and language concepts and statistical symbols associated with the concepts. In this work by Carroll, Flaherty, and Ovenden (Reflections on Sustainability Issues in Learning Object Development, 2019), they reflected on the stages of the design and implementation of learning objects and concluded that the Plan, Act, Observe and Reflect cycle worked well for the project team, in addition to providing recommendations to increase the sustainability of learning objects.

Beeck and Kowalik in their recent work (From cradle to grave: The life cycle of a digital learning object, 2019) discuss the life cycle of a **DLO** because many times hosts change, and links get broken. The discussion comments on the management of digital assets, but concludes that there must be a greater effort in dealing with the definition of a process, to ensure that "current users of online products are not thrown into a digital abyss when an item is removed from service" (Beech & Kowalik, 2019, p.

563). Especially because teachers and institutions may be using the material in their practices and be surprised by its unexpected unavailability.

The study presented by Chien, Ning Su, Wu, and Huang (Enhancing students' botanical learning by using augmented reality, 2019) is another example of recent research related to the use of technology to aid learning. In this research, they used augmented reality (**AR**) technology to provide visualizations of the real-world environment simulated by a computer connected to a target learning object, to increase the effectiveness of learning in the learning activities that involve the observation of specific plants of the botany area. The digital learning object (**AR**) was used to provide multifaceted views of the plants under study, thus improving the learning experience.

This study validated the effectiveness of the approach with 45 participants (26 men and 19 women) from an elementary school in southern Taiwan. The results were measured according to Bloom's cognitive levels and were as follows.

> Students in the experimental group observing the plants through AR had significantly greater comprehension compared with those in the control group, with respect to conceptual analysis and identification of leaf arrangement. The findings suggest that compared with the traditional learning approach involving plant observation, AR-based learning material could significantly enhance students' higher-level cognitive capabilities, enabling them to more effectively scaffold knowledge about target plants in the observational learning activity. (Chien, Su, Wu, & Huang, 2019, p. 1)

In other words, the result was positive in relation to the use of **AR** as a **DLO** in the studied learning process, demonstrating the real potential of using DLOs as auxiliary teaching tools.

Another recent work is that of Cavalcante, Moreira, and Sales (Uma proposta de objeto digital de aprendizagem para o ensino de ondas sonoras, 2019) who presented their proposal for the development of a **DLO** on sound waves, more specifically on the behavior of these waves in accordance with the fundamental wave equation. The **DLO** was developed to be used with high school or senior students. They point out in their work that there are not many works related to **DLO** that contemplate the subject (just as it was also noted in this doctoral research the non-existence of works that contemplated the use of **DLO**s for teaching VFX in audiovisual courses). Due to this scarcity of **DLO**s on the behavior of sound waves according to the fundamental wave equation, the authors pointed out the need for their development to contribute to the improvement of the teaching-learning process.

This work by Cavalcante et al. serves as inspiration for this research, for the desire to also contribute to a teaching theme not yet explored by **DLO**s.

DiBattista was another author who produced an interactive **DLO** to assist college students at Brock University, St. Catharines, Ontario, Canada, in order to provide a lively, set-based explanation of the solution to the Monty Hall (MHD) dilemma to increase the understanding of the solution. A total of 189 undergraduates (156 women and 33 men) enrolled in an introductory statistics course taught by the author voluntarily participated. In the end, it was realized that the **DLO** can be considered highly effective in its objectives.

However, DiBattista points out in his work that “Although there is a rich literature on the technical aspects of learning objects, there has been relatively little research on their effectiveness in promoting learning (Kay & Knaack, 2008).” (DiBattista, 2011, p. 56).

This is, therefore, one of the foundations that justify the importance and relevance of this Ph.D. research, because it aims to assist in this foray about the effectiveness of the **DLO**s in promoting learning.

The study by Scott, Morris, and Marais (Medical student use of digital learning resources, 2018) conducted in the Child and Adolescent Health (CAH) block of Sydney Medical Program, Australia, which focuses on the use of digital learning resources for students of medicine showed how much the current generations of students privilege the extensive use of digital resources for directed self-learning, in addition to showing that a good part of these students do not read the bibliographic indications (physical books and recommended readings). A few use groups for studies, and face-to-face and personal groups (40%) are still superior to online groups (6%).

The recent research by Amador et al. (Development of an Instrument for the Determination of Learning Objects Quality for Students with Visual Impairment Integrating the Services Theory, 2019) developed with 15 high school students with visual impairment (blindness) from the Multiple Care Center (CAM) number 5, from Aguascalientes City, Mexico, in addition to being relevant, also believes in the importance of developing instruments for determining the quality of learning objects, in the specific case for students with visual impairments.

In the quote “Another problem is that the LOs evaluation is usually done by an expert in the area, leaving aside the opinion of the user.” (Amador, et al., 2019, p. 45) indicate the importance that the quality assessments of learning objects are also based on the user's opinion, something that this research follows and aims to, by seeking feed-back directly with users, with the interest of ranking the most relevant attributes for the tool.

The book “E-learning for Geographers” (Fill, Conole, & Bailey, 2008) is another good example of an effort made by the UK Joint Information Systems Committee, a body charged by the Higher Education Funding Councils to encourage new electronic learning, knowledge and skills in using digital materials. The book is a reference for geography teachers in the evolution of e-learning, pointing out the best ways to integrate new technologies in learning, which tools are available, which is the best combination of online learning and face-to-face learning, among several other indications and examples to inspire teachers to develop their own materials and enhance student learning.

The recent work presented by Fernández, Pérez, Pérez, and Salinas (Digital Learning Objects for Teaching Telemedicine at University UNIANDES-Ecuador, 2019) based on the investigative work arises from the issues in the University Regional Autónoma de Los Andes, and that is related to the limited use of technological elements in the educative process that carry out the teachers of the Career of medical Sciences of this Institution. The work had as its general objective “To elaborate learning objects about Telemedicine so that they serve as a technological element in support of the educational process.” (Fernández, Pérez, Pérez, & Salinas, 2019, p. 337). The research carried out among teachers and students of the institution concluded that there is lack of knowledge about learning objects and telemedicine. Also, the research points out that teachers do not use technology as an educational support element.

The research concluded that “Learning objects are essential elements in the modern educational support of top-level educational processes; its application allows the achievement of meaningful learning” (Fernández, Pérez, Pérez, & Salinas, 2019, p. 345), in addition to “The incorporation of learning objects as elements of educational support it generates a culture of teaching by technology and a positive impact among students, because most of them are digital natives.” (Fernández, Pérez, Pérez, & Salinas, 2019, p. 345).

It is, therefore, another example of positive impact and recommendation for incursions by teachers from all areas of knowledge, which reflect on the incorporation of these new digital media to improve their teaching processes, enabling the evolution that they have so long predicted necessary for the traditional teaching.

Research carried out by Hawera, Wright, and Sharma at The University of Waikato, New Zealand, focuses on issues related to the teaching of mathematics in the schools of Aotearoa. Something interesting punctuated in the study refers to the national curriculum.

> The New Zealand Curriculum states that “schools should explore not only how ICT can supplement traditional ways of teaching but also how it can open up new and different ways of learning” (Ministry of Education, 2007, p. 36). Te Marautanga o Aotearoa (Ministry of Education, 2008) also states that the use of ICT across the curriculum is critical for learners. Regardless of whether students are learning mathematics in English or Māori-medium classrooms, digital technologies (DTs) can increase the range of instructional resources available to both teachers and learners. Digital learning objects (DLOs) are a group of resources available to New Zealand teachers and initial teacher education (ITE) programmes. Digital technologies used in primary schools, such as DLOs, have the potential to help students see what happens when they manipulate geometric shapes, numbers or formulae. (Hawera, Wright, & Sharma, 2017, p. 81).

In summary, we can see the institutional importance given to the use of **ICT**s throughout the curriculum and how **DLO**s have great potential in helping to learn. Finally, the results of the research carried out brought important information to the field of study, as can be seen in the following quote.

> These results show that the ITE students saw DLOs as resources that could consolidate or reinforce learning after the main teaching has been completed. Perhaps such responses indicate that these ITE students do not see the DLOs as having a place in the center of their teaching program related to key mathematical ideas but at the periphery. It is heartening to see that students were still able to suggest a range of alternative uses also for the DLOs that included supporting struggling students, introducing the topic of area, catering for visual learners, and independent learning. (Hawera, Wright, & Sharma, 2017, pp. 85-86).

As shown in the quote above, other studies also report the validation by **DLO**s students as an accessory, peripheral tool, that is, that does not replace the teacher or traditional teaching itself, but supports and complements the learning process. This will be the purpose of the prototype to be developed during this doctoral research, it will not be designed to be used in the educational environment autonomously, but to assist and facilitate the learning process of students in teaching **VFX**.

Another relatively recent study is the one developed by Medina, García and Olguín, at the Instituto Tecnológico Superior Zacatecas Norte, Mexico, where the allocation and use of **DLO**s with augmented reality were researched, to support the teaching and learning process of 18 students of the seventh semester of the "Engineering in Administration" degree, on the theme "Research Workshop II", considering the student's learning style according to the VARK model. As a result, it was realized that "augmented reality supports and as a consequence improves the learning process of students." (Medina, García, & Olguín, 2018, p. 56), in addition, an interesting contribution of the research is presented below.

> Taking advantage of new technologies in education is a task that should not be overlooked in the educational field, since technologies are useful tools to support the teaching-learning process. The use of digital learning objects with augmented reality is a feasible option that can be taken up so that not only in institutions of higher level are implemented, but in all educational levels. (Medina, García, & Olguín, 2018, p. 56)

In other words, it corroborates with research that seeks to prove the effectiveness of using **ICT**s as instruments to support the educational process.

The work developed by Judith A. Wiener (Easing the Learning Curve: The Creation of Digital Learning Objects for Use in Special Collections Student Training, 2010), using PowerPoint as **DLO** to assist in training students who work in the special collections and archives departments at The Ohio State University, sought through the creation of **DLO**s to assist the learning process by better qualifying students working with libraries (and other sectors) as well as reducing the time spent by the teams responsible for providing this type of training. However, the research developed showed that although the digital manuals created allow any changes or modifications to be made easily and inexpensively, the commitment of technology-experienced employees is necessary to make the necessary modifications and updates to them, to keep them current, useful, and in use by training teams. In addition, as these activities take time, provisions for reviews and assessments at a centralized institutional level are recommended, as the individual departmental model used in the research showed a lack of organizational and / or political commitment to maintain the training program.

That is, if there is no team responsible for maintaining the **DLO**s, they may become obsolete over time, or simply fall into disuse due to the lack of knowledge of the tool available (if there is no training policy that can be passed on to another person who takes over hierarchical function responsible for its implementation and continued use), or even for lack of commitment or understanding of its usefulness for the purpose for which it was designed.

The work of Halverson, Wolfenstein, Williams, and Rockman (Remembering Math: The Design of Digital Learning Objects to Spark Professional Learning, 2009), although less recent, reports an research based on the creation, implementation, and evaluation of a series of objects of learning for remembering mathematic for adults. Over the course of two years, 12 web-based learning objects were built and tested with 59 adult students. Finally, it was concluded that the **DLO**s produced significant learning gains with the target audience, proving to be another type of use with positive results.

Another work that, although not very recent, is very interesting, associated with the development of DLOs, is that presented by Machado, Augusto, Marcelino, and Mustaro (Measurement of Resources and Investments to Develop Digital Learning Objects, 2008) in which they seek to evaluate the architecture of objects of digital learning and create metrics - based on the analysis of financial, administrative and software engineering aspects - to define a forecast of the investment needed to develop the digital learning object.

The research also sought to collect the tools and languages used for the process of developing learning objects and collected the following data “Macromedia Flash, C/C++, Visual Basic, HTML, PDF, Streaming Video, PHP, MySQL, XML, Java, Javascript, Photoshop, Flex, and JSP.” (Machado, Augusto, Marcelino, & Mustaro, 2008, p. 343), despite this, “From the survey it was possible to verify the difficulty in getting answers related to learning object development process, especially in relation of the cost measure and getting an approach value of the necessary investment.” (Machado, Augusto, Marcelino, & Mustaro, 2008, p. 343).

The above section shows part of the difficulty as there are many varieties of **DLO**s types and different technical possibilities for their creation. In addition, each knowledge area has very different elements and needs in terms of content and complexity for the creation of its own **DLO**s.

Something interesting in this research is that “was verified that only 85% of the interviewed use some methodology to develop a learning object. Some of the methods described were Waterfall Cycle, Life Cycle and ADDIE.” (Machado, Augusto, Marcelino, & Mustaro, 2008, p. 343). In other words, although a good proportion of respondents use a methodology for the development of learning objects, this methodology is not standardized, and a portion does not use any type of methodology for the development of **DLO**s.

The authors' intention is very important and valid because “this research expects to contribute for the institution of methodologies that cannot only make possible the measurement of the investments related to a development of learning object, but also presents the professionals and resources involved in this process.” (Machado, Augusto, Marcelino, & Mustaro, 2008, p. 347).

The research found in Nicholas Ford's master's thesis (Digital learning objects: design for learning, 2015) is also an example of experimentation with **DLO**s that sought to investigate the relationships between the modalities of presenting **DLO** information and learning.

His research defends the need to consider students' cognitive and affective processes when creating **DLO**s “Specifically, by the Cognitive-Affective Theory of Learning from Media (CATLM) (Moreno, 2006) and the Cognitive Theory of Multimedia Learning (CTML) (Mayer, 2005)” (Ford, 2015, p. 118), as the results of the research suggest that the modality of instructional messages presented by DLO supported learning and learning perceptions, affecting students' cognitive processes.

The research carried out by Meskill and Sadykova (The language of digital learning objects: A cross-disciplinary study, 2009) at the University at Albany, NY, USA, is a very interesting and even timeless study as it highlights the languages used by different areas of the knowledge to address the most diverse topics. The study does a linguistic analysis of 1,691 peer reviews from the MERLOT repository to identify particular trends in the sciences, humanities, and education. The research specifies the variation in word choice, sentence size, sentence structure, and descriptive/analytical uses of language that have emerged between disciplines. The analyzes undertaken seek to suggest points of convergence and divergence that can guide principles and standards for instructional design in addition to assisting in dialogue and interdisciplinary collaborations around teaching and learning.

An interesting quote from Meskill and Sadykova's work follows below.

> As the world of information grows more dense and complex, so too do academic disciplines. As a result, disciplinary language becomes increasingly compartmentalized with a loss of mutual intelligibility between and across disciplines becoming more than a remote possibility. Such divisions have often been cited as limiting intellectual growth and discovery due to lack of communication between groups. (Meskill & Sadykova, 2009, p. 251).

In other words, the increasing divisions and specializations between the areas of knowledge of humanity, while it is natural to deepen specific discussions, unfortunately also lead to this side effect of limiting the growth and discovery that comes from the exchange of information, and knowledge that may permeate the different types of knowledge.

With this concern, the authors' final placement is very interesting, they suggest “an awareness building and promotion of mutual respect for one another’s epistemologies and practices as expressed in what is ostensibly a common language of teaching and learning.” (Meskill & Sadykova, 2009, p. 251) in addition to believing that “With faculty from diverse disciplines now finding themselves in mixed venues for the purpose of developing instructional technologies, opportunities for broadening their instructional horizons through cross-disciplinary conversations abound.” (Meskill & Sadykova, 2009, p. 251), positively reinforcing the integration between the different areas and the scientific fertility that such exchanges and interactions can provide.

The work developed by Silveira, Neutzling, Santos, and Brondani (Usage of digital learning object about breast cancer in primary health care, 2012) is an example of using **DLO** outside the formal university or educational scope. The authors developed a **DLO** on breast cancer for use at the Health center in the south of Brazil with 16 members of a climacteric group.

The **DLO** was developed by the Virtual Teaching Laboratory - Nursing (Levi-Enf) at the Federal University of Rio Grande do Sul (UFRGS) using the Adobe Flash CS4 and Adobe Fireworks CS4 and “The population of study shows average of 63 years old with variation of between 51 to 78 years old” (Silveira, Neutzling, Santos, & Brondani, 2012, p. 151).

> The authors of this review intended to evaluate this kind of educative material with users of primary health care, analyzing their evaluation and perceptions, trying to stimulate the self care and health promotion, as well as the digital inclusion. Beyond that, this research brings up the discussions of the practice of health education with the computer, few implemented with the users of the Unified Health System in Brazil. (Silveira, Neutzling, Santos, & Brondani, 2012, p. 150).

The study evaluated **DLO** through users relative to content, usability, and educational material. It presented positive results, in addition to finding that it attracted the interest of women and changed their perspective of computing, promoting changes in their self-esteem when learning the computer, and finally.

> The proposed objectives were achieved, demonstrating the satisfaction of users with digital material and provided with new learning, this can be a useful tool to be used by nurses in health promotion. It is believed that the "digital inclusion" has become possible and that group was important to the effort. With this study, we can use technology not previously explored and underutilized spaces in the field of study, which increases self-esteem and self-image of participants. Therefore, it is suggested to the Health Center the use of his computer lab for the benefit of their community. It is expected that projects like this can continue and lead to new discoveries related to health education with computer support and encourage the use of the tool by health professionals in primary health. (Silveira, Neutzling, Santos, & Brondani, 2012, p. 155).

In other words, it was possible to verify that the use of a **DLO** in this context of learning and raising awareness about health issues was a great application. It would deserve greater attention and new incursions for the use of these learning technologies both in the health area, as in other areas not directly related to formal education, but which can also benefit a particular community or target audience.

The study developed by Bavaresco, Muller, and Rech (Contribution of digital learning object “Futsal RIVED” in the process of teaching and physical education, 2014), aimed to evaluate the contribution of a **DLO** in the teaching-learning process in the discipline of Education Physics for 4th-grade students of the Escola Municipal Coração de Jesus in the Municipality of Segredo, Rio Grande do Sul, Brazil. The students were aged between 9 (71%) and 10 (29%) years, the majority being male (60%). The **DLO** used is called “Futsal RIVED” which presents a pedagogical proposal for teaching the fundamentals of futsal.

The **DLO** was explored interactively both individually and in groups, it was analyzed, discussed, and explored according to the instructional objectives proposed by the **DLO** itself. The research showed that students more easily identified and recognized the fundamentals of futsal and better understood its execution, and “with that, learning becomes dynamic and efficient, and there are greater enthusiasm and interest in both theoretical and practical classes." (Bavaresco, Muller, & Rech, 2014, p. 553). Following are two quotes that present the contributions of using **DLO** to students.

> Through this methodology, students were motivated, as they had differentiated learning, in a playful and fun way, better understanding the content and consequently with better performance on the court. They assimilate the rules better, relating theory to practice, making content more attractive, experiencing new experiences, and learning with more satisfaction. (Bavaresco, Muller, & Rech, 2014, p. 553).
>
> It is concluded, then, that the technologies applied in education as pedagogical resources acquire the function of assisting in the teaching-learning process, bringing new perspectives and different ways of learning, but that it is also important to work on subjects of interest and that is part of the reality of the students. (Bavaresco, Muller, & Rech, 2014, p. 553).

The production of visual effects in audiovisual, as it is a niche of specialized performance, despite sometimes appearing in some of the course subjects of courses related to audiovisual production, is usually not dealt with in-depth, but only approached superficially through teaching basic compositions with chroma-key and notions of motion graphics. Thus, a possible difficulty to be overcome is recognized here, to bring this type of production, and technologies closer to the students, so that they can feel as possible and real the field of study and performance in question, in order to generate more interest with the content to be taught.

The research carried out by Busanello et al. (Evaluation of a digital learning object (DLO) to support the learning process in radiographic dental diagnosis, 2015) evaluated a **DLO** developed to improve the diagnostic skills of radiographic dental changes. The **DLO** was developed using Adobe Photoshop CS5, Microsoft Office PowerPoint 2010, and Microsoft Visual Basics for Application (VBA) applications and was evaluated by 62 undergraduate students (24 male and 38 female) who were taking a course diagnostic imaging (Dental Radiology Discipline of the Dentistry School).

> The results show that test group performed better than the control group in both tests, with statistically significant difference (P = 0.004 and 0.003, respectively). In overall, female students were better than male students. (…) The results obtained in this study suggest that students who used the DLO performed better than those who used conventional methods. This suggests that the DLO may be a useful teaching tool for dentistry undergraduates, on distance learning courses and as a complementary tool in face-to-face teaching. (Busanello, et al., 2015, p. 222)

The scores indicated high results regarding the **DLO** use in relation to several aspects such as effectiveness, efficiency, easiness to browse, and satisfaction. In addition it presented positive confirmation of the use of **DLO** for better student performance compared to conventional teaching methods, which signals for teachers and courses to seek to incorporate such **ICT**s in the teaching and learning process of their students.

Akpinar's quote (Different Modes of Digital Learning Object Use in School Settings: Do We Design for Individual or Collaborative Learning?, 2014) in his research on the individual and collective use of **DLO** at Boğaziçi University, Turkey, below is interesting because comments that in the reference model chosen for his research (SCORM) the **DLO** is constituted for individual and not collective use.

> The sharable content object reference model (SCORM), aims to provide access to materials tailored to individual needs, delivered cost-effectively anytime and anywhere. All elements in SCORM are accompanied by meta-data defined according to a standard called learning object metadata. These standards and SCORM framework neglect the social interaction principle of knowledge integration (Akpınar & Şimsek, 2007). Further, there is no group in SCORM, identifying relations between users is not considered, and therefore aggregating individual users' interaction data into a group's interaction data is not possible. Maybe due to weakness in industrial standards of LOs; design, development and evaluation of collaborative use of Los have not sufficiently been studied. (Akpinar, 2014, p. 88)

In other words, it makes an important and interesting warning, that perhaps **DLO**s should also be designed for collaborative use. Within this perspective, we can infer that other design variables can be used to improve student engagement, motivation, and development, such as ranking, competition, and gamification, for example.

A less recent but no less relevant work is that developed by Janson and Janson (Integrating Digital Learning Objects in the Classroom: A Need for Educational Leadership, 2009), l emphasizing the importance of the commitment of the entire educational institution in the evolution and modernization of the teaching and learning processes. In addition it comments on the relationship between the use of

DLO by teachers, their difficulties and need for technological competence and teaching methods compatible with such technologies.

> That said, DLO integration inevitably creates challenges; teachers need to invest extra time and energy learning about and implementing DLOs (Wetterling and Collis 2003) and overcoming the technological challenges that come with any innovation (Freebody 2007). Our previous research demonstrated that complex factors affect the learning value derived by students from DLOs (Janson, Janson, and Falloon 2007). Once DLOs are integrated into the classroom, how they are used and what benefits they provide are shaped by the teacher's technological competency and preferred teaching modes. (Janson & Janson, 2009, pp. 1-2)

Janson and Janson, supported by a grant from the Microsoft New Zealand's Partners in Learning Program, carried out an research at a small primary school in Wellington, New Zealand, with 8 teachers and 200 students (aged 8-10), where they looked to follow a process to assess the advantages and disadvantages of educational use of **DLO**s from the point of view of teachers. In summary, their research.

> Explores the opportunities and challenges inherent in using digital learning objects and reports on the impact of DLO use at both the classroom and school levels. By providing research that links students' use of DLOs with the development of key competencies, we hope to sharpen instructors' vision of how DLOs can help them achieve their educational goals and to encourage DLO uptake among teachers. (Janson & Janson, 2009, p. 1).

The results of the study indicate “that **DLO** integration in schoolwide learning activities requires different types of school leadership at different uptake stages” (Janson & Janson, 2009, p. 5). In other words, an initial commitment by the entire institution is necessary to enable a transition to an educational environment that takes advantage of the best of **ICT** in the teaching and teaching process. Moreover.

> DLOs have another unique role to play in educational leadership development. DLOs can be designed to help educators overcome their initial resistance to innovation uptake and understand the powerful teaching potential technology-rich learning environments represent. School principals wishing to build collective capacity and develop staff members are already experimenting with the unique e-learning models facilitated by DLOs. In this way, early adopters of educational technology can display leadership in facilitating transformational e-learning experiences for their peers. (Janson & Janson, 2009, p. 5).

Thus, although the beginning of any transition, improvement, and alteration in standard procedures is difficult and presents resistance and disbelief from many of the actors involved, the most diverse studies are proving the positive use of digital media, **ICT**s and **DLO**s for the evolution of education in different countries and at the most varied levels of education.

The study developed by Martin and Mahaffy, although less recent, is totally relevant because it has some similarities with the current research. Just as this research seeks to assist in a complex pedagogical task that involves a lot of theoretical and technical knowledge related to the production of visual effects in audiovisual products, the study by Martin and Mahaffy also seeks through The King's Center or Visualization in Science (Edmonton, Canada) developed a broad range of digital learning objects addressing many aspects of Global Climate Change, also considered complex within the disciplines of chemistry and physics.

> The complexity of systems such as our climate makes them difficult to understand because they are composed of multiple interrelated levels that interact in dynamic ways (Hmelo-Silver, 2007).

> Additional pedagogical challenges are introduced by the requirement for learning concepts from different disciplines. Learning science through complex systems poses major pedagogical challenges, particularly to disciplinarily oriented undergraduate science education that is delivered primarily by conventional lecture-based pedagogies. This challenge calls for new tools and new resources to help learners cross disciplinary boundaries, and new inquiry-based pedagogies to facilitate learner engagement with complexity Structure-Behavior-Function theory (SBF) research on differences in expert-novice understanding of complex systems (Hmelo-Silver, 2007) suggests that the largest differences in understanding between expert and novice groups is in understanding causal behaviours and functions. Making connections among different levels of a complex system increases working memory load, and requires mental simulation to construct complete mental models (Graesser, 1999; Narayanan & Hegarty, 1998). (Martin & Mahaffy, 2010, p. 52)

The complexity of teaching and understanding climate systems and Global Climate Change meant that there was a willingness to create **DLO**s to facilitate teaching and learning in selected areas from elementary school through to graduation in a wide range of disciplines. In short, an extensive set of **DLO**s was devoted to climate science and global climate change. The result showed that **DLO**s "not only serve disciplinary needs in helping students understand topics in chemistry and physics but more significantly, enable them to understand more fully the complex climate change issues that their generation must face" (Martin & Mahaffy, 2010, p. 56).

Likewise, this research seeks to assist in a complex educational task, which also requires interaction between different disciplines, concepts, and techniques, and its main objective is to assist in overcoming the difficulty of articulating these elements in order to achieve the final objective that is the production of VFX.

The research developed by Mehlhorn, Parrot, Mehlhorn, Burcham, Roberts, and Smartt (Use of Digital Learning Objects to Improve Student Problem Solving Skills, 2011) was developed to assess DLO usage.

> In summer 2010, University of Tennessee at Martin faculty were surveyed to determine their attitudes toward using a digital pen to develop learning objects (…) This initial survey revealed a need to determine if students are positively impacted through viewing the DLO in conjunction with typical classroom activities. (Mehlhorn, et al., 2011, p. 3).

For this, two sections of an introductory agricultural course were compared during the spring and fall semesters of 2010. One group (n = 28) using a traditional classroom and another group (n = 29) using a traditional classroom environment with a **DLO** developed by an instructor with examples of solving a mathematical problem step by step.

As a result, 84% of respondents (n = 27) indicated the learning objects created with a digital pen saved time when developing online course materials.

> Another interesting finding from the survey was that faculty used the digital pen to develop materials for traditional undergraduate courses (59%). The survey also revealed that 41% of the faculty used DLO for online undergraduate courses. The pen can also be effectively used in a traditional class and not just for distance education. (Mehlhorn, et al., 2011, p. 5).

In the students' perception, "The majority of students revealed the DLO was helpful in preparing for exams." (Mehlhorn, et al., 2011, p. 6). In addition, "The findings did indicate the majority of students viewed the DLO positively, and it can be a useful teaching tool." (Mehlhorn, et al., 2011, p. 6). In other words, the tested DLO was evaluated very positively as a useful teaching tool.

However, "One measure of effectiveness of any teaching tool is how it impacts student's performance on exams and assignments." (Mehlhorn, et al., 2011, p. 7) and when comparing the results between the students of the experimental group and the control group, there was no statistically significant difference between the results of the two groups.

In other words, despite the positive potential devolution of the tool, its use did not alter the results of the exams. This is an interesting factor and noted in other studies that will be presented later also.

> Overall, student perceptions of the DLO were positive, but they did not show improvements in overall student performance in the class for exams and assignments. As with most tools designed to increase student performance, there is no guarantee of success. In the end, it is still up to the individual student to work hard and be prepared for the class. Instructors can provide all the materials for students to succeed except the drive to be successful. (Mehlhorn, et al., 2011, pp. 8-9).

> It was assumed that student performance would be greater for all aspects of the DLO enhanced course as compared to the traditional course. Again, faculty cannot guarantee student success simply by developing better teaching materials. They can help with student outcomes, but the student is still responsible for putting in the necessary effort to be successful. (Mehlhorn, et al., 2011, p. 11).

The study is important because it highlights the importance and responsibility of the student in the teaching and learning process, as it is the student's responsibility to make the necessary effort for success. That is, as much as the tool is the best possible, there is no guarantee of success.

Topal's recent work, Yildirim and Önder (Use of Educational Films in Environmental Education as a Digital Learning Object, 2020), sought to investigate the effects of educational films on students' levels of knowledge and attitudes related to the environment, in addition to discovering the opinions of students in the experiment. In the study, they used a qualitative and quantitative method in a study group consisting of a total of 44 students selected from two classrooms that were studying at the 5th-grade of a middle school in the Osmangazi district of the province of Bursa in Turkey, and the data collections tools "The study used the Environment Knowledge Test developed by Cömert (2011), the Environment Attitude Scale developed by Atasoy (2005), and a semi-structured interview form developed by the researchers." (Topal, Yildirim, & Önder, 2020, p. 136).

The following are three quotes related to the research results, which reveal that there was no significant difference between test and control groups at the end (as well as reported in other surveys), despite the students' report that the use of films while **DLO** was beneficial and contributed to a better understanding of the classes.

> As a result of the study, there was no significant difference between the mean pre-test knowledge scores of the students in the experiment group who were given environment education with educational movies and those in the control group who were given environment education without educational movies ($p > .05$, $t = -.53$). Additionally, the knowledge test mean scores of the students after the implementation significantly differed between the groups in favor of the experiment group ($p < .05$, $t = -4.05$). (Topal, Yildirim, & Önder, 2020, p. 143).

> Another finding in this study was about the effects of educational movies on the attitudes of middle school students towards the environment. As a result of the analysis, no significant

> difference was found between the groups in terms of their mean pre-test attitude scores before the implementation (p> .05, t = .515). There was also no significant difference between the post-test mean scores (p> .05, t = -.53). (Topal, Yildirim, & Önder, 2020, p. 143).
>
> The students reported that educational movies were beneficial for their learning of the topic, contribute to better understanding of the course and the class that was held this way was more permanent. When the literature is reviewed, it may be seen that this result that was revealed by the views of the student was in agreement with those of several studies. Barnett, Wagner, Gatling, Anderson, Houle and Kafka (2006) reached the conclusion that popular movies were effective for students to make sense of scientific concepts and develop their mental structures. Likewise, several researchers reported that educational movies affected learning positively (Beuscher, Roebers, & Schneider, 2005; Birkök, 2008, Linebarger, Kosanic, Greenwood, & Sai Doku, 2004; Pekdağ & Le Marechal, 2007; Stoddard, 2009) and provided permanence for classes (Akbaş, Canoğlu, & Ceylan, 2015; Butler, Zaromb, Lyle, & Roediger, 2009; Sullivan-Kerber, Clemens, & Medina, 2004; Walker, 2006; Watts, 2007; Woelders, 2007). (Topal, Yildirim, & Önder, 2020, p. 144).

The research by Fonseca et al. (Impact of the Use of a Digital Learning Object in the Teaching of Clinical Assessment of Preterm Infants: A Comparative Study, 2012) aimed to "to assess the cognitive learning of undergraduate nursing students on the clinical assessment of the preterm infants aided by the use of a digital learning object (DLO) linked to the Internet compared to the traditional classroom method." (Fonseca, et al., 2012, p. 1192).

The developed **DLO** was the "Semiotechnique and semiology of the preterm infant (FONSECA et al., 2009) which presents advanced, computerized and interactive technology with simulations that allow the approximation to reality, presenting, gradually, the complexity and the specificities of premature infants" (Fonseca, et al., 2012, p. 1193), and the study had the participation of 21 undergraduate students being subdivided into two groups, the control group with 10 members and the experimental group, with 11, of which 21 participants 90% (n = 19) were women and were between 18 and 25 years old, and each of the two male participants (who were over 26 years old) stayed in one of the respective groups.

The interesting thing about this research is that in addition to having used a number of students very close to this Ph.D. research, it was also developed with students from a Brazilian public university and the data analysis based on the results of statistical tests of pre and post-tests, it turned out that.

> There was no statistically significant difference between groups (p>0.05), however, it was documented, based on subjective assessment, a high level of satisfaction with the use of the educational technology and interest in the dissemination of the strategy to other themes and moments of the course. (Fonseca, et al., 2012, p. 1192).

Other research that focuses on the use and evaluation of **DLO** that can be taken as an example are the following.

The research on the influence of digital learning objects on concepts of zoology concepts in Portugal in which they considered "possible positive influence of **DLO** on the educational process" (Danhão, Frenedozo, Schimiguel, & Coelho, 2019). They also say that "if teachers use the appropriate digital objects they can be helped in the teaching and learning process, because they will be inserting the theory with examples and language recognized by the students, in a more playful and illustrated." (Danhão, Frenedozo, Schimiguel, & Coelho, 2019).

The use of learning objects for the development of skills among students with hearing impairment by Mahmoud (Mahmoud, 2019). The evaluation of didactic sequences and digital resources in the potentiating of the learning of algebraic concepts, where “The data indicate that it is feasible to use digital tools in combination with other resources that enable the student to establish the relationship between theory and practice.” (Macedo, Castro-Filho, & Lautert, 2019).

Bartek and Nocar's research represents the main features of **DLO**s used in mathematics teaching in the Czech Republic's primary schools (Bártek & Nocar, 2018).

Research has been found on the use of **DLO** for teaching computer programming in elementary school students (Topali & Mikropoulos, Digital Learning Objects for Teaching Computer Programming in Primary Students, 2019); in the Use of **DLO** in Religious Education (Mitropoulou & Faridou, 2018); the use of Digital Learning Material in Gymnasium Music Curriculum in Estonia for high school students aged 17-19 years “The preliminary results encourage the compilers that the created material is generally already well-produced and positively received by the students.” (Lock & Selke, 2018).

Another collective effort is that found in the Nordplus Project: Networking, new skills and co-creation in Nordic Higher Education. Held between Nordic countries to introduce emerging mixed education environments, developing specific **DLO**s for each discipline (Harbo, Jönsson, & Tonning, 2019).

McGuinness and Fulton's research at University College Dublin, Ireland is also valuable as it aims to “to develop a suite of original interactive digital skills e-tutorials to be embedded in undergraduate and postgraduate courses” (McGuinness & Fulton, 2019). Apart from that “contributes useful insights to the body of literature on user engagement with digital learning objects in higher education, as well as students’ perceptions and experience of blended learning” (McGuinness & Fulton, 2019).

Regarding the term **BL** in interaction with the term **DLO**, there is also a doctoral thesis in Psychological Studies in Education at University of Alberta, Canada, by Todd Michael Sumner (Exploring Differential Levels of Feedback in Digital Learning Objects, 2017) that investigated through of a quantitative study the effect of differentiating the levels of feedback (simple, positive and negative) in **DLO**s. The study with 141 randomly selected participants suggested through the participants' comments that “the digital learning objects were useful as a learning tool both on their own or as a supplement to learning in a face to face setting.” (Sumner, 2017, p. 125). It resulted in a positive evaluation regarding the investment and effort to use **DLO**s as a learning tool both autonomous and for blended learning.

Here is some research related to Blended Learning.

Within the universe of research related to **BL**, there are researches such as that developed by Bowen, Chingos, Lack, and Nygren (Interactive Learning Online at Public Universities: Evidence from a Six-Campus Randomized Trial, 2014) where they searched randomly on six public university campuses of an online statistics course on prototypical interactive learning the effect of learning in the student. On each of the six campuses, one group used the hybrid format and the other the traditional format.

They found that learning outcomes are essentially the same “That students in the hybrid format are not harmed by this mode of instruction in terms of pass rates, final exam scores, and performance on a standardized assessment of statistical literacy.” (Bowen, Chingos, Lack, & Nygren, 2014, p. 94). In addition, they also carried out speculative cost simulations and found that the adoption of hybrid instructional models in large introductory courses “...has the potential to significantly reduce instructor compensation costs in the long run” (Bowen, Chingos, Lack, & Nygren, 2014, p. 94) which would assist in the process of cost reduction to face the financing management for higher and lower education in the USA.

This is one of the works (among many existing ones) that addresses the economic advantages of adopting the **BL**, which can serve as a reference for decision-making by institutions that are also undergoing contingency, as in the case of Brazilian Federal Universities, as previously mentioned.

Another recent research related to blended learning is that developed by Baranova, Khalyapina, Kobicheva, and Tokareva (Evaluation of Students' Engagement in Integrated Learning Model in a Blended Environment., 2019) at Peter the Great Saint-Petersburg Polytechnic University, in Sankt-Peterburg, Russia. In the survey, they developed an integrated learning model for the purpose of assessing student engagement by trying to identify the impact of such a model on student learning outcomes and determine whether the level of engagement influences learning outcomes.

> The study involved 3rd-year undergraduate students from Peter the Great St. Petersburg Polytechnic university, who were enrolled in an integrated learning course (N = 63). Students are 20 years old. The group consists of 37 girls and 26 boys. (Baranova, Khalyapina, Kobicheva, & Tokareva, 2019, p. 4).

For this, they used qualitative and quantitative data and research and interviews on behavioral involvement, emotional involvement, and cognitive involvement.

The integrated approach (blended learning) positively impacted the students' results and the analysis showed that the involvement had an influence on the learning results that were also highly impacted. In the words of the researchers “we can conclude that, due to the introduced integrated learning model, students were involved in the educational process and had a high level of engagement and, therefore, achieved high results.” (Baranova, Khalyapina, Kobicheva, & Tokareva, 2019, p. 11)

Research developed during Mary Dankbaar's Ph.D. (Serious games and blended learning; effects on performance and motivation in medical education, 2017) indicated that “for knowledge acquisition, a blended course design is equally effective and attractive as a classroom-based course design. In postgraduate training, a significant reduction in training costs can be achieved with blended learning, without compromising performance” (Dankbaar, 2017, p. 59).

The study developed by Nortvig, Petersen, and Balle (A literature review of the factors influencing e-learning and blended learning in relation to learning outcome, student satisfaction and engagement, 2018) is very important and interesting because it did a literature review through 44 peer-reviewed papers published between 2014 and 2017 in an attempt to understand the factors that influence e-learning and blended learning in relation to learning outcome, student satisfaction, and engagement.

Two relevant quotes are transcribed below.

> Several studies have compared face-to-face teaching to online learning and/or blended learning in order to try to define which of the formats provides, e.g., the highest learning outcome, creates the most satisfied students or has the highest rate of course completion. However, these studies often show that teaching and learning are influenced by more than teaching format alone. (Nortvig, Petersen, & Balle, 2018, p. 46).

> The factors that are highlighted by the literature reviewed to be of specific importance for professional education students' learning experience and their learner identity include the presence of appropriate teaching and learning spaces online as well as off-line and the presence of engaging and meaningful learning communities that support the students' social relations. (Nortvig, Petersen, & Balle, 2018, p. 53).

In other words, the teaching format, although important, should not be taken as the only element for success or failure in the teaching-learning process, but other elements must be incorporated both in the actions and in the evaluations of these experiences. Special attention should be given to appropriate spaces, both in traditional teaching environments and in providing guidance to students and their families in the need for a great context when they are engaged in online activities. The effort to create surrounding communities to support social relations must also be the object of action, as it is with the union of these various internal and external factors that the learning experience can be improved.

Changing to the research developed by López-Pérez et al. (Blended learning in higher education: Students' perceptions and their relation to outcomes, 2011), for instance.

> In Spain, according to data from the Spanish Conference of University Rectors (CRUE, 2009), 71.8% of university teaching and research staff make use of the institutional virtual teaching platform and 92.5% of students make use of this platform. University students are knowledgeable regarding Internet technologies and, in general, recognize the utility of this resource. (López-Pérez, Pérez-López, & Rodríguez-Ariza, 2011, p. 818).

In other words, since 2009 in Spain, there has already been a trend towards the use of institutional virtual teaching alongside traditional teaching, in order to make **ICT**s improve and complement traditional teaching.

The research carried out by López-Pérez et al. was developed through a blended learning experience that was carried out in the General Accounting subject offered by the University of Granada, for first-year undergraduate courses and the final sample comprised 985 valid, completed questionnaires, and the sample was considered to be representative of the population. Its first objective was "to analyze the effect of a blended learning experience on the outcomes obtained." (López-Pérez, Pérez-López, & Rodríguez-Ariza, 2011, p. 819), and as a second objective "to examine the extent to which the blended learning experience created such a relation between the students' perception (the subjective measure) and the final mark awarded (the objective measure)." (López-Pérez, Pérez-López, & Rodríguez-Ariza, 2011, p. 819).

The study revealed interesting results, as explained in the following quote:

> That the implementation of blended learning has a positive effect on reducing dropout rates and in raising exam pass rates in the subject. Moreover, it is shown that the joint effect of the blended

> learning activities has a positive influence on the students' final marks. While their perception of the utility of e-learning activities alone does not affect the final marks, the results obtained reveal that e-learning activities support and complement FTF classes, and thus the joint effect is explanatory of the final marks. Accordingly, we may consider that e-learning activities complement, rather than replace, traditional forms of learning (Mitchell & Forer, 2010). This view coincides with the conclusions of other studies (Alexander, 1999; Crawford et al., 1998; Donnelly, 2010). Furthermore, the motivation generated by FTF activities is explanatory of the final marks; the teacher achieves a greater degree of involvement by students in the learning process, and this has a subsequent positive effect on their final marks. There exists a link between students' perceptions and their objective results (Crawford et al., 1998), both because these elements are associated and because they are explanatory, i.e., there exist relations of causality among them. (López-Pérez, Pérez-López, & Rodríguez-Ariza, 2011, p. 824)

In other words, the perceived usefulness of e-learning activities alone did not affect the final grades, but it generated motivation and involvement of students in the teaching-learning process, which generates a positive consequence perceived by students and teachers.

The following quote also illustrates the strengths of using blended learning.

> According to our study, a high degree of utility, motivation and satisfaction is perceived from blended learning, which could lead students to have a positive attitude towards learning. Moreover, this conclusion indicates that blended learning reinforces students' understanding of the subject in question, enhancing and supporting the learning process (Lei, 2010). (López-Pérez, Pérez-López, & Rodríguez-Ariza, 2011, p. 824).

And in relation to the students 'commitment to the research results, the quote below shows that the use of **BL** somehow motivated greater attendance to classes, indirectly reflecting on the students' commitment and perseverance, consequently affecting the final grades.

> In addition, we observed a correlation between blended learning variables and others that influenced students' final marks, namely class attendance, background and age. This finding shows that the influence of blended learning activities on final marks may also take place in an indirect manner. The relation between blended learning activities and class attendance could indicate that greater student commitment and perseverance is being achieved and, moreover, that this consequence affects the final marks achieved – as has been concluded by Donnelly (2010) and Woltering et al. (2009). With respect to background, it has been shown that students with a better background tend to benefit more from the blended learning experience. (López-Pérez, Pérez-López, & Rodríguez-Ariza, 2011, p. 824).

To conclude this section, the quote from Dziuban, Graham, Moskal, Norberg, and Sicilia (Blended learning: the new normal and emerging technologies, 2018) below illustrates well that the incorporation of new technologies in teaching through **BL** is becoming increasingly most common and standard, demonstrating the inevitability of discussions and forays into the area.

> Blended learning (BL), or the integration of face-to-face and online instruction (Graham 2013), is widely adopted across higher education with some scholars referring to it as the "new traditional model" (Ross and Gage 2006, p. 167) or the "new normal" in course delivery (Norberg et al. 2011, p. 207). (Dziuban, Graham, Moskal, Norberg, & Sicilia, 2018, p. 1).

In the next section, projects more focused on **DLO** design will be presented.

2.2.3. Design and production of learning objects

According to the research of (Dias, Kemczinski, Lucena, Ferlin, & Hounsell, 2009, p. 3), for a digital content to be considered a learning object, it must have characteristics that can be divided into two areas: (1) pedagogical and (2) technical. Below we have two tables (Table 2.2 and Table 2.3) with a brief identification of the characteristics and their concepts.

Table 2.2 - Pedagogical Characteristics

Feature	**Concept**
Interactivity	The system supports to realizations and mental actions.
Autonomy	Learning resources that provide autonomy, encouraging initiative and decision making.
Cooperation	Users exchange ideas and work collectively on the concept presented.
Cognition	Refers to the cognitive overloads placed in the learner's memory during instruction.
Affection	It is related to the feelings and motivations of the student with his learning and colleagues.

Source: (Dias, Kemczinski, Lucena, Ferlin, & Hounsell, 2009, p. 3).

Table 2.3 - Technical Characteristics

Feature	**Concept**
Accessibility	A learning object from a remote location can be used in many other places.
Aggregation	Resources can be grouped into larger sets of content, including traditional course structures.
Autonomy	Checks whether the object can be displayed individually.
Classification	It allows the cataloging of objects, helping them to identify them, easier the work of search engines.
Digital	On the computer, it is worked digitally.
Durability	Allows continuing to use educational resources when the technological base changes, without redesign or re-coding.
Interoperability	It involves using learning objects in different places, regardless of tools or platforms.
Reusability	The reusability varies according to the granularity of the learning object.

Source: (Dias, Kemczinski, Lucena, Ferlin, & Hounsell, 2009, pp. 3-4).

This project will seek to build upon the research already done on how to design a learning object so that its development is guided by the correct guidelines already studied and continuously in the process of validation.

In a work supported by the **UNESCO** and carried out with the partnership of the Ministry of Education of Brazil (**MEC**) and **CAPES** (Coordination for the Improvement of Higher Education Personnel) among other institutions, the following quote is highlighted:

> It should be noted that, as in any lesson plan, the proper selection of a learning object for use in didactic activity is defined based on the objective that is intended to be achieved in learning a given content. By looking at this question, the Learning Object can be an excellent ally of the teacher in the classroom. (Tarouco, Ávila, Santos, Bez, & Costa, 2014, p. 12).

In the meantime, one of the main objectives for the proper design of the learning object that is being proposed in this project will be to develop a tool that can help students to assimilate and put into practice the basic theoretical and practical concepts of the production of visual effects for movies, to integrate real and virtual images.

According to Tarouco et al. (2014, p. 23), the project of constructing a learning object involves multidisciplinary skills, for this one can use the theoretical principles of instructional design of Gagné, Wager, Golas, and Keller (2005), where it is necessary to establish:

a) the objectives of the teaching material;

b) the target audience (their skills, knowledge, preferred learning styles, cognitive styles);

c) the interface (with a view to maximizing usability);

d) interactivity strategies;

e) the tools that will be used for its construction;

f) and available human and financial resources.

These factors are defended as influencers in the size and quality of the object to be developed, and for this reason, will deserve the due consideration during the execution of this research.

For the execution of the project, the authoring tools (for instance the platforms InVision, Prott, Mockup.io, among others) will give much support to the development of the prototype. In the need to transform a particular prototype into an Application (mobile app), there are platforms where it is possible to generate App without the need for advanced programming knowledge too. Some examples of platforms for this are Mobincube, Appy Pie, OutSystems, AppSheet, among others. "Authoring tools are essential resources for teachers to develop digital pedagogical content without the need to know a specific programming language " (Tarouco, Ávila, Santos, Bez, & Costa, 2014, p. 99).

> The evolution of authoring tools has contributed to a new scenario in which the production of digital educational material has been less and less restricted to the group of programming and design experts. Tools that provide the addition of interactivity and multimedia resources to digital content, without the need for programming, have provided the teacher with a new panorama, in which he sees himself not only as a user but also as a professional able to prepare their own Learning Objects. (Tarouco, Ávila, Santos, Bez, & Costa, 2014, p. 196).

This facility provided by technology is helping an increasing number of teachers to create their own learning support tools, reducing the fear of relying on skills that they do not have or in multi-professional teams that they may not have access to. The possibility of self-production of learning objects contributes to the advancement of research in the area, allowing more researchers to create different learning objects for different pedagogical contents and to gauge how much technology has actually contributed to the educational act.

In the context of the bibliographical review, one should indicate an experiment carried out in Brazil at one of the public federal universities (**UFRGS** - Federal University of Rio Grande do Sul). A learning object was developed for the teaching of cinema. The software was used as a support for Fundamentals of Cinema course, which was taught for three undergraduate degrees (Journalism, Publicity, and Propaganda). At the end of this work, they concluded that:

> Perform an activity like this is not as simple as it first seemed. There are many unfolding and testing of an object of order to see the object as a whole function, both in terms of form and content. However, its development shows that it is possible to create interactive learning objects that use various information and resources available on the internet. (Sortica & Rossini, 2008, p. 29).

The research reported a direct connection with the construction of learning objects for the teaching of theoretical contents related to the audiovisual area at the higher level. It can be shown as one of the closest experiments to what this project proposes, although the content taught is different. The lack of further research on the application of learning objects in the teaching of audiovisual production (at undergraduate level), corroborates with the previously presented survey, that there are few teachers in higher education qualified for pedagogical reflection since the few publications on this subject evidenced the lack of teacher pro-activity in search of better educational tools (analog or digital).

Another important reference material for the production of **DLO**s is the work of Rachel S. Smith (Smith, 2004) by The New Media Consortium (NMC) which offers practical advice for designing a **DLO** based on such concepts as usability, reuse, objects centered and oriented to the student, current metadata standards, accessibility, and even marketing tips.

Braga in her work (Objetos de aprendizagem, volume 2: metodologia de desenvolvimento, 2015) comments that in relation to methodologies and processes for the development of learning objects, three most common types have been used.

> There are three types of approaches that have been used for the development of LOs: the first are methodologies that strongly consider instructional design (the pedagogical aspects), others that consider only the software development process (computational aspects) and others, still, which mix a little of these two aspects. (Braga, 2015, p. 25)

The author also presents some approaches, such as ADDIE (Analyze, Design, Develop, Implement and Evaluate) considered one of the oldest within the instructional design "since, when the ADDIE methodology was created, the concept of **LO** has not yet existed." (Braga, 2015, p. 26). In addition to other creation processes proposed by some entities linked to the creation of DLOs such as RIVED (from the Distance Education Secretariat), SOPHIA (from the Software Solutions Laboratory of the University of Vale do Itajaí), as well as the RUP method (Rational Unified Process) considered a more complete process.

The author makes an analysis and comparison between these methods and the identification of instructional design activities in the methodologies used for the development of learning objects. Subsequently, starting from the analysis carried out, he proposes a new methodology through his research group named INTERA at UFABC (Federal University of ABC) that seeks to contemplate the pedagogical activities contained in the ADDIE approach and the computational activities contained in the disciplines of the RUP. The INTERA methodology (Intelligence, Educational Technologies, and Accessible Resources) is then focused on reuse, technical quality, and Instructional Design.

The quote below is very interesting and valid because it highlights the common problems that exist in **LO** development methodologies.

> The failure to adopt a methodology in the development of LO is partly due to the fact that the existing processes are not as widespread and because it involves multidisciplinary knowledge. Some methodologies are generic for the development of didactic-pedagogical content, others are methodologies only for the development of software, and others were developed specifically for LO. The generic methodologies for the development of didactic content, in general, were created by professionals in the field of Education and have a more pedagogical than technical approach, leaving aside a more technical approach and not taking into account the quality

> attributes of LO, including the issue of reusability. The methodologies for software development cover only technical aspects and do not take into account the pedagogical question. The methodologies developed specifically for the development of LO also have flaws both in the pedagogical issue as well as in some technical and quality aspects. (Braga, 2015, p. 44).

As explained, there are many methods of designing **DLO**s. This research will seek to use the two complementary lines, technical/technological and instructional/pedagogic, to create a **DLO** that is well executed both with technical and pedagogical quality.

Chapter 3 - RESEARCH METHODOLOGY

3.1. The methodology established in the research project

This section concerns the methodological elements defined since the development of the research project, where are found how this research was classified, the definition of the planning of the research stages, and the description of the methodological application.

3.1.1.Classification

Based on the work of Umberto Eco (2007, p. 33) , which seeks to guide how to make a thesis, this research follows its principles in the choice of topic because: The choice is one that corresponds to the interests of the proponent; It has accessible sources and is within reach of the candidate's material; The sources to which the work is referred are in the cultural scope of the candidate; and the methodological framework of research is also within reach of the candidate's experience.

According to Antônio Joaquim Severino:

> The doctoral thesis is considered the most representative type of monographic scientific work. It is a single subject approach, which requires research of the scientific area in which it is located, with specific methodological instruments. This research can be theoretical, field, documentary, experimental, historical or philosophical, but always dealing with a single, specific, delimited and restricted theme. (Severino, 2007, pp. 150-151)

From the examples given by Severino, this research fits into experimental research, but to better classify it will be used as a parameter the classification proposed in the work of Antônio Carlos Gil: Methods and Techniques of Social Research (2008) and How to Elaborate Research Projects (2002). In addition, the proponent also works in line with what Goldenberg wrote:

> Most social science researchers now admit that there is no single technique, only one valid way of collecting data in all surveys. [...] The choice of working with statistical data or with a single group or individual, or both, depends on the issues raised and the problems that are to be addressed. [...] Each researcher should establish the data collection procedures that are best suited to their particular purpose. (Goldenberg, 2004, p. 62).

Considering that the proposed research is based on an experimental method, the method that provides the logical bases of the research to be used will be the inductive method, because:

> According to the inductive reasoning, a generalization should not be sought a priori but verified from the observation of concrete cases to confirm the reality. (Bacon, Hobbes, Locke, Hume), for which knowledge is based exclusively on experience, without taking into account pre-established principles. (Gil, 2008, p. 10).
>
> In this method, "one begins with the observation of facts or phenomena whose causes one wishes to know" (Gil, 2008, p. 10), later comparison is made with the intention of discovering the relations between them and finally "generalization is made, based on the relationship between the facts or phenomena” (Gil, 2008, p. 11).
>
> The conclusions obtained through induction correspond to a truth not contained in the assumptions considered, differently from what happens with the deduction. Thus, if by deduction we arrive at true conclusions, since based on equally true assumptions, through induction we arrive at conclusions that are only probable (Gil, 2008, p. 11).

According to Gil, for a study to be recognized as genuinely experimental, it is necessary to present some characteristics, such as a) "first, it is necessary that the individuals participating in the experiment compose two groups: experimental and control. Inclusion in one or the other group should be done by a random distribution process. " (Gil, 2008, p. 52); and b) "individuals in the experimental group should be subjected to some type of influence stimulus or, in other words, to the action of the independent variable." (Gil, 2008, p. 52).

This research will follow the guidelines above since it intends to work with two groups (one experimental and another for control) that will be composed of undergraduate students related to the audiovisual production area. These students will be randomly distributed among these groups, and one of these groups will use as support in their learning process the learning object conceived by this research, while the control group will not make use of the pedagogical tool. In this way, the experimental group will be subjected to a stimulus/influence of an independent variable, defining this research as a genuinely experimental method search.

> Experimental method is a scientific method. It is oriented to the future in the sense that the researcher is seeking to evaluate something new. It is a process of contribution to the already acquired fund of knowledge. Thus, the experimenter operates under the basic assumption that the research situation he wishes to evaluate has never existed and does not now exist. Situation here means in the sense of a programme, curriculum or method for organizing class, as well as a ‘situation’ created to test. (Singh, 2006, p. 134).

In Gil's second work, he argues that in general the experiment represents the best example of scientific research, for essentially "experimental research consists in determining an object of study, selecting the variables that would be able to influence it, defining the forms control and observation of the effects that the variable produces on the object. " (Gil, 2002, p. 47).

Gil (2002, p. 48) also points out that, contrary to popular opinion, experimental research does not necessarily have to be performed in the laboratory. It can be developed anywhere as long as it meets your basic assumptions. In addition, he comments that "[...] experiments are occurring more and more frequently in the human sciences, especially in Psychology (for example: learning) " (Gil, 2002, p. 48), which is in line with this project, that also seeks to research a learning situation with the validation of the use of a digital learning object for Higher Education.

3.1.2.Stages of research planning

The research is classified as an experimental research and it will use as technical procedures both experimental research and bibliographical research, then will be presented the planning stages, subdivided here into nine steps.

The beginning of planning occurs in the formulation of the **problem (1)**. "More than any other, experimental research demands that the problem is put in a clear, precise and objective way" (Gil, 2002, p. 93). The problems have already been presented in the research questions, in this way, one starts to construct the **hypothesis (2)**.

> Because experimental research is characterized by clarity, precision, and parsimony, it often involves a single hypothesis. This, in turn, tends to be confused with the problem itself. What

> varies is the form: interrogative in the problem and affirmative in the hypothesis. (Gil, 2002, p. 94).

The hypothesis of this research is that with the use of the proposed digital learning object there will be better results in the pedagogical process. That is, the pedagogical tool will help in the execution of the proposed practical exercise, also facilitating the understanding of the theoretical bases and technical aspects involved.

Starting with the **operationalization of the variables (3)** the research will seek to constitute two groups of students, where one of the groups will be exposed to a variable and the second group will be taken as control group. In other words, for the validation of the program (digital learning object), both groups will be considered and one of the groups will use the software to carry out a final exercise to be defined, and the other group will not have this help of the tool to the same execution.

Regarding the **definition of the experimental plan (4)**, Parametric Analysis will be used in the research, so a minimum of 35 to 40 subjects per group will be necessary to guarantee statistical significance (to capture differences if they exist) and to ensure some normal distribution of results. The experimental plan that involves the manipulation of a single independent variable is also called a "one-way" (Gil, 2002, p. 94).

> The parametric tests are the tests of the most powerful type and should be used if their basic assumptions are based upon the nature of the population values and the way that sample have been selected: 1. The observations are independent. The selection of one case is in no way dependent upon the selection of any other case; 2. The population values are normally distributed or, if not, the nature of their distribution is known; 3. The population values have equal variances or the ratio of their variances is known; 4. The variables measured are expressed in interval or ratio scales. Nominal or ordinal do not qualify. (Singh, 2006, p. 232).

Regarding the **determination of the subjects (5)** "When planning an experiment, it is necessary to determine with great precision the population to be studied. For this, the characteristics that are relevant to the clear and precise definition of the population must be considered (Gil, 2002, p. 98). In the case of this experiment, students from undergraduate courses that will be chosen to participate in this research, whose courses have a direct link with the audiovisual production, i.e. courses such as Cinema and Audiovisual; Animation Cinema; Radio and TV; Image and Sound; or Communication in Digital Media.

In addition to the requirement to be a student, it may be necessary to restrict participants to those who have completed at least half of the total load of their course (4 semesters, for example, in a course lasting 8 semesters). This restriction may be necessary due to the previous necessary content (minimum knowledge and prerequisites of some theoretical and technical concepts) for the good pedagogical conduction of the experiment. The restriction may be important for a better leveling of students' and adequacy of the content of the research to the degree of qualification of the research subjects.

> Too often, the populations we are studying are so large that it is impracticable to consider them in their entirety. This means that the researcher must choose some subjects and study them. In order for this choice to be adequate, the experimenter should use the technique of randomization, which aims to provide each subject with an equal chance of being chosen. (Gil, 2002, p. 98).

To allow this equality of chances for the subject to be chosen, the following procedure will be used as the technique for this randomization. The experiment will be publicized as an improvement course (teaching activity) where students will receive a training/qualification on the basic principles for the production of visual effects (integration between real and virtual) and already knowing (and giving consent) about experimental research which will be done with the subjects in this course. Those interested and having the profile that qualifies them for participation in the project will have a deadline to make the application. At the time of registration, the candidates will respond to a small survey in the application form itself providing information such as gender, age, semester, and other information.

After the registration period has ended (where all students with the profile will have the same conditions to apply to participate in the experiment), a number will be assigned to each candidate.

Determination of the environment (6):

> It has already been remembered that experimental research may have an environment in the laboratory or the field. When it is performed in the laboratory, the possibility of controlling the variables is much greater, since the environment can be prepared in a way that allows the maximization of the effect of the independent variables on the dependent variable. In the field experiments, the control of the variables is greatly reduced, both as a costly undertaking and as a way of artificializing natural situations (Gil, 2002, pp. 99-100).

Some environmental variables were listed in the following Table 3.1, in order to clarify the problem that such variables could cause to the experiment. At the same time we point out possible control solutions so that these items do not interfere with the results.

Table 3.1 - Environment variables to be considered/controlled

Variable	Problem	Solution
Computers for the execution of practical exercise (hardware and software).	The use of different computer labs for each group can influence learning.	Use of the same lab for both groups. With identical computers (in hardware and software configurations).
Environment (physical space) for the execution of the practical exercise. Common classroom or recording studio.	The use of different physical spaces for each group can influence the learning, considering that they can have differentiated infrastructure.	Adopt a single space for the execution of the exercise. Recording studio or classroom where it is possible to have more variables controlled and replicated (such as light and sound).
Equipment to practical execution of exercise (video cameras, light reflectors, light intensity and color meters, tripod, etc.).	The use of different equipment can influence the comparison between the groups to be compared, since each equipment has a different degree of complexity of the operation, leading, therefore, to a greater difficulty or ease in the execution of the exercise.	To seek to use the same set of equipment in all the times that the practical exercise will be carried out, so that all the groups can be exposed to the same degree of complexity and difficulty, allowing isolating the variable (digital learning object) in the best possible way.

In view of the variables presented, the research will be carried out at a public federal university in Brazil, since the researcher is a member of the faculty of one of these universities, has greater autonomy with the institution's managers in order to better manage the space (environment), the laboratories and equipment. This greater autonomy will help to better control these variables and better isolate the variable, the digital learning object. In addition, it is an important aspect also emphasized by Gil in the following fragment.

> In order for the environment to become the most suitable for the research, a lot of care must be taken. First, it is necessary to ensure that the phenomenon occurs in a sufficiently pure or remarkable form so that the research becomes feasible. This, of course, requires appreciable knowledge of the environment. It is also necessary to ensure that the researcher has the authority and expertise to dispose of the environment appropriately. This is very important when it is considered that research is often carried out in environments whose administration is entrusted to outsiders. (Gil, 2002, p. 100).

In this context, the researcher already has knowledge of the infrastructure of the computer labs, their processing capacity, the possibility of installing the software required for the execution of the work, the availability of a recording studio or classroom for the execution of the exercises in a controlled manner, the equipment available for the execution of the practical didactic exercises. This set of conditions will allow an added value for the validation of the methodological procedure adopted for the research.

As the research will take place in two distinct stages, the first one is the realization of the tool (prototype design) and the second stage the use of the tool (learning object) in the educational environment, the proponent has guaranteed the infrastructure for the execution of both the steps in the same educational institution.

Advancing to the **data collection stage (7)**, "experimental research is done by manipulating certain conditions and observing the effects produced" (Gil, 2002, p. 100). Following this conception, each group, after concluding the qualification course where they will perform a practical exercise of learning, will respond to a questionnaire.

The data collection will be carried out in two stages, the first, where tests will be carried out regarding the design of the tool and the user experience with it. In this first step, it will be performed user interaction tests that will cover everything from concept to sketches and prototypes. In the second stage, where the prototype is already developed, it will be used for experimentation of its use in the educational environment, for this second moment to carry out the analysis of its pedagogical functions and teaching facilitators.

At this moment, each of the groups will evaluate the relevance, recommendation, intention to use, and other variables related to the educational program to be further defined after major bibliographic review. "Decis offer an even greater refinement to the researcher, being able to classify the categories of a variable into 10 parts." (Martins & Theóphilo, 2017, p. 109). The scales that will be used are a variation of the Likert scale because, in the scale developed by Rensis Likert at the beginning of the '30s, the participant of the research externalized his reaction choosing one of the five or seven points of a scale (Martins & Theóphilo, 2017, p. 93). Although 4-point and 5-point scales allowed us to evaluate the main effects of univariate and multivariate analyzes such as ANOVAS and MANOVAS, it is not possible to see safely as interactions, that is, the effects that are generated when one of the variables of the analysis interacts/changes depending on another variable. Thus, as scales with more points/more linear, there is better statistical discrimination of the interactions (Marôco, Análise de equações estruturais: Fundamentos teóricos, software e aplicações, 2010). In this research, the questions will be answered on an 11-point scale (zero to ten) because with this kind of scale it is possible to ensure less distortion of respondents' responses, i.e. maintain the scale's linearity. In fact, shorter scales often suffer from statistically very asymmetric response profiles at the extremes, with distributions of responses very concentrated at the highest and lowest points of the scales (i.e., left-tailed and right-tailed wall distributions) (Anderson, 2001) in addition, this methodology will be used both to measure parameters related to user experience dimensions and to learning-related parameters. This questionnaire will be drawn up in the form of a social climbing.

> Social scales are instruments constructed with the objective of measuring the intensity of opinions and attitudes in the most objective way possible. Although presented in a variety of ways, they basically require the researcher to indicate, within a graduated series of items, those that best correspond to their perception of the fact researched. (Gil, 2008, p. 136).

Gil elaborates on the definition, stating that "Social scales aim to enable the study of opinions and attitudes in a precise and measurable way. This implies transforming facts that are usually seen as qualitative in quantitative facts " (Gil, 2008, p. 137). The second conceptualization on escalation would be "Rating is the term applied to the expression of opinion or judgment regarding some situations, object, or person. These opinions are usually expressed on a scale or by categories of values, either quantitatively or qualitatively. " (Singh, 2006, p. 202).

After defining the method for the collection as a questionnaire in a social scale model, the next step will be the **analysis and interpretation of the data (8)**:

> In experimental research, generally, one uses statistical analysis. The development of the statistical techniques has been remarkable and its applicability in the experimental research so adequate that nowadays one cannot fail to use them in the data analysis process. (Gil, 2002, p. 100).

Briefly, the analysis and interpretation of the data will be subdivided into two stages. In the first stage where the dimensions of the tool design and the user experience will be analyzed. And in the second stage the pedagogical dimensions of the use of the tool in an educational environment.

For these analyses, it will be used the traditional forms of analysis of the Likert-type scales (still without division by groups for the collection of data - design and user experience); And later, tools for descriptive and inferential statistical analysis using **SPSS** (Statistical Package for Social Sciences[3]) can be used to compare the two groups (experimental versus control group) in the evaluation of the data of the pedagogical dimension of the tool. After collecting these data, the differences between the means of the different groups can be tested in relation to the dimensions indicated by a set of multivariate variance analyses (MANOVA).

> Many times multivariate techniques are extensions of univariate techniques, as in the case for multiple regression, which extended simple regression (with only one independent variable) to a multivariate analysis where two or more independent variables could be used. A similar situation is found in analyzing group differences. [...] Both of these techniques have long been associated with the analysis of experimental designs. (Hair, Anderson, Tatham, & Black, 2010, p. 345).

[3] According to Marôco, the SPSS is a “(…) software for manipulation, analysis, and presentation of data analysis results” (Marôco, Análise Estatística com Utilização do SPSS, 2007, p. 21). The version used in the research was 19. More information about SPSS Statistics at https://www.ibm.com/analytics/spss-statistics-software.

The use of this technique results from the need to control the type 1 error, that is, to affirm that there are significant differences between the groups when they do not exist.

In the second stage, the attributes of the software (digital learning object) will be analyzed. For this stage, the **MaxDiff** technique (Maximum Difference Scaling) will be used to measure the strengths and weaknesses of the program (hierarchize) in order to be able to propose some kind of improvement to the tool. **MaxDiff** is a technique used to collect information about attitudes, needs, and motivations, allowing the calculation of the amounts of the items in question. This technique is likewise suitable when the items of each attribute are not mutually exclusive. In relation to the software dedicated to this calculation:

> MaxDiff software makes it easy for researchers with only minimal exposure to statistics or advanced statistical methods to conduct sophisticated research involving the scaling of multiple items. (…) The trade-off techniques used in the MaxDiff System are very robust and easy to apply (for example, much easier to use than the related conjoint analysis). The resulting item scores are also easy to interpret. You do not need to have any formal training in statistics to use our MaxDiff System well and to achieve good results. (Sawtooth Software, Inc., 2013, p. 2).

In order to complete the research planning, the last component is the **stage of presentation of the conclusions (9)**, where the assumptions can be made to confirm or reject the hypothesis of this research.

3.1.3. Description of methodological application

To describe more objectively the application of the methodological structure presented the research will use user experience design concepts such as the ones proposed by Bill Buxton (Sketching user experience: getting the design right and the right design, 2007) and Greenberg, Carpendale, Marquardt, and Buxton (Sketching User Experiences The Workbook, 2012) that make the necessary recommendations for a good interaction design project, where there are already established methodologies for the production of sketches and prototypes. These interaction and user experience design methodologies will be used for the interaction design, the structuring of the system architecture, storyboards, sketching, prototyping, and evaluations.

This research will seek to design a prototype that has the capacity to at least simulate or be functional for the execution of a certain use situation (of the several that the software would be able to execute) so that it is possible to evaluate it both in the dimension of the interaction and experience (software), as in the pedagogical dimension (pedagogical object).

In order to do these evaluations, there will be a first stage exclusively dedicated to the development of the prototype, where will be tested interactions with users to define the concept of the tool, ranging from concept until tests with sketches and prototype versions. Upon completion of a final prototype, the research will go on to assess the pedagogical dimensions of the tool.

> It is known that a learning object consists of a technical and a pedagogical portion, however, the technical evaluation of the learning objects must be performed in the testing stage. This is suggested because it is necessary to try to exhaust the technical problems of the learning object before entering the evaluation stage so that the technical errors do not influence the pedagogical gain that one wishes to measure in the evaluation stage. (Braga, 2015, pp. 155-156).

Into the pedagogical evaluation part, a mini-course on the subject will be given (about producing visual effects using the interaction between real and virtual images). The participants will be divided into two distinct groups, where a group will be used as a control group that will not use the developed application to help in the execution of the practical exercises, while the other group will use the tool to help in the pedagogical process of the execution of this exercise. After the conclusion of the theoretical part of the course, there will be a practical exercise to be performed (where the software will be used in that group) and after the end of the practical exercise, at the end of the course, the participants will respond to a questionnaire that will be produced using **SPSS**, MANOVA and **MaxDiff**. It evaluates both the dimensions of the learning object in relation to design aspects and in relation to the pedagogical dimensions.

The project will also seek to perform an evaluation of the results through a blind test, comparing the results/expectations reached by each group without the evaluators knowing what works were developed with the aid of the learning object developed by this research. This enables to obtain more data concerning the possibility of productivity gains that the tool could provide due to the automation functionality that will be implemented in the prototype.

3.2. The methodology developed and applied after the CAT

In this Ph.D., after the evaluation and approval of the research project by the Thesis Monitoring Committee (**CAT**) occurred on October 18, 2018, his “Report on Thesis Plan Acceptance” points out that as the research work is being developed and described, the thesis gains strength. That is, new methodological elements could be listed and described in greater detail in the course of carrying out the investigation itself. Thus, other methodological elements will be presented below, which were better detailed during the research work. It is in the clash with the methodological and feasibility difficulties that the research is put to the test so that it adapts itself to achieve its objectives, overcoming the difficulties initially foreseen.

3.2.1. Variables control

For the experimental part of the research, methodological precautions were necessary for its correct execution, such as the manipulation of an independent variable, ways of controlling and observing the effects, random distribution, among others. The forms of control that needed to be observed and adopted were as follows:

- Random distribution of the research participants into 4 groups.
- Computer lab, where the practical activities of the mini-course were executed, with all the computers (workstations) with the same technical specifications, that is, the same hardware and software configurations, so that possible differences could not interfere in the quality of the practical exercises developed.
- Subdivision of time into equal sections for the execution of each of the practical activities during the mini-course.

- Same practical exercises with the same levels of difficulty (equivalents) to be performed by all students participating in the mini-course because creative freedom would make it impossible to compare qualitatively between the practical works developed.
- Definition of the independent variable and the control group, where the variable was the use or not of the tool (**DLO**) in the aid of the data collected during the filming and later transposition of the data to computer graphics software using the script generated by the tool.
- The use of the same video images shot together by all participants of all groups at the same time (but each group collects data during the shooting in a different way) so that they can perform the integration exercises with the same degree of difficulty.
- The avoid completely practical exercises with similar activities before the experiment so as not to incur into the "training effect" and compromise the samples later.

Works that served as the basis for this organization and methodological care for the experimental part for consequent statistical and ethical validity were (Goodwin, 2010), (Coolican, 2009), (Hair, Anderson, Tatham, & Black, 2010), (Singh, 2006).

3.2.2. Model for experimental execution

The initial methodology proposed the use of two distinct groups (an experimental and a control group), with the expectation of 35 to 40 subjects per group. However, in order to anticipate possible problems of the methodological and practical execution of the short course/research to be developed, a preliminary survey was prepared to better understand the profile, interest, and availability of students, the target audience of the research.

In this way, through an online form, disseminated in an online and physical way, a brief profile of these possible participants was raised, in addition to being able to find out what would be the best time for the execution of the mini-course and research to attract as many interested people as possible.

In addition to drawing this approximate profile, it was possible to have a dimension of the number of possible interested participants. This preliminary research is more detailed and described in topic 5.4 (Preliminary consultation of interest in participation in mini-course/research), where it is possible to know it in greater depth.

With this estimate in mind and: a) knowing that other students who did not respond, they could later be interested in participating in the mini-course/research; b) knowing the natural difficulties so that the students really carry out the activity this participating in the research; c) being aware in advance that the future number of actual participants is usually much lower than the actual number of interested parties; d) and knowing the technical limitations of space and number of computers in the laboratory available for carrying out the activities. As a precaution, a new methodological strategy was planned beforehand so that even with a real rate of adherence lower than the number of participants expected and desired as an initial goal (35 to 40 participants per group), it would still be possible to carry out the research and assess numbers with statistical relevance for the reflections and conclusions intended.

In this way, the idea of working with two groups (one experimental and the other a control group) was maintained, however in a different methodological configuration.

The methodological approach aims, at first, to teach a short course with the intention of transmitting content about the production of visual effects with integration between real and virtual images, in addition to balancing the knowledge of students participating in the research on the subject. In a second moment, students perform practical exercises on the knowledge acquired during the mini-course, so that they can then test the prototype to be used during practical teaching activities. For this moment, they will be subdivided into four groups that will perform practical exercises at two different times as subdivided below (between with and without the aid of the tool - Digital Learning Object - DLO):

Moment 01:
Group 1 - Exercise A (with DLO)
Group 2 - Exercise B (with DLO)
Group 3 - Exercise A (without DLO)
Group 4 - Exercise B (without DLO)

Moment 02:
Group 1 - Exercise B (without DLO)
Group 2 - Exercise A (without DLO)
Group 3 - Exercise B (with DLO)
Group 4 - Exercise A (with DLO)

Such subdivision will allow each group to perform both proposed practical exercises (with and without the help of the tool), allowing for more advanced statistical analysis later, even if there are fewer participants.

When performing practical activities, there will therefore always be a control group that will not use the "digital learning object" tool to perform the task, while the other group will use the tool. After completing the mini-course and its practical activities, students will respond to a research form composed of questions in a linear scale format (Likert scale or Décis) (Martins & Theóphilo, 2017) and others in a maximum difference format (format "**MaxDiff**").

For questions in the "**MaxDiff**" format, all individual forms for each research participant will have the questions ordered randomly by the research software itself (**XLSTAT**), to avoid deviation of answers due to fatigue and order of the questions. The research, therefore, will be inter and intra-subjects. After this interaction with the respondents, the research will end when using the audiovisual product produced by the students participating in the research to carry out a blind analysis.

These audiovisual products (without the identification of their authors or the group to which they belonged) will be evaluated by professionals and professors in the field (external to this research) who will evaluate the products. Later will be possible to analyze whether the best-evaluated products belong in their majority to the group who used the learning object, or if there is no qualitative difference (due to possible time savings and consequent productivity) in the evaluation of the final products, in the comparison between the groups.

In Table 3.2 below it is possible to see the possible comparisons that can be made using this methodology of execution of activities.

Table 3.2 - Possible comparisons that can be made

	Order AB	**Order BA**
Tool in the **1st task**	**I** - A(w/)B(w/o) N= 5	**II** - B(w/)A(w/o) N= 5
Tool in the **2nd task**	**III** - A(w/o)B(w/) N= 5	**IV** - B(w/o)A(w/) N= 5

A and **B** - 2 roughly equivalent exercises
(w/) - with the tool
(w/o) - without the tool

The following are the possible comparisons (most important in "**bold**" because the other possible comparisons predict the absence of differences).

1. Intra-subjects (repeated measures)

- **The task with tool (w/) vs. without tool (w/o)**
  N = 20 [aggregates all conditions, I, II, III, IV]
- Task A with the tool (w/) vs. task B without the tool (w/o)
  N = 10 [aggregates the conditions I and IV]
- Task B with the tool (w/) vs. task A without the tool (w/o)
  N = 10 [aggregates the conditions II and III]

2. Between-subjects

- **1st task with the tool (w/) [conditions I and II: N = 10] vs. 1st task without the tool (w/o) [conditions III and IV: N = 10]**
  Expected result: I&II better than III & IV
- **2nd task with the tool (w/) [conditions III and IV: N = 10] vs. 2nd task without the tool (w/o) [conditions I and II: N = 10]**
  Expected result: III & IV better than I&II
- Task A with the tool (w/) [conditions I and IV: N = 10] vs. Task A without the tool (w/o) [conditions II and III: N = 10]
  Expected result: I&IV better than II & III
- Task B with the tool (w/) [conditions II and III: N = 10] vs. Task B without the tool (w/o) [conditions I and IV: N = 10]
  Expected result: II&IV better than II & III

Therefore, the rotational group procedure of the experiment was adopted, considering that all groups will perform practical exercises with and without the help of the tool. Below, a quote from Singh regarding this type of methodological arrangement.

> The rotation group method is used to secure control of pupil factors when groups cannot be thoroughly equated. It also neutralizes the teacher-variable. In general, it overcomes the chief weaknesses of both the one group and the equivalent group methods. Since in the rotation group design each variable is applied to each group, it is not necessary that the groups be exactly equated. Of the three designs of educational experimentation, this is the most valid but the most complicated too. (Singh, 2006, p. 144)

3.2.3. Project Ethical Analysis - REC e NREC

The research because involving a Portuguese research institution and being carried out in Brazilian territory is classified as international research by Brazilian institutions.

The entities involved are NOVA School of Science and Technology (**FCT**) of the NOVA University of Lisbon (**NOVA**), Portugal, and the Federal University of Paraíba (**UFPB**) in the city of João Pessoa, Brazil.

Besides, because it involved human beings (students of undergraduate courses related to audiovisual production), it needed to be submitted to the Research Ethics Committee (**REC**) and later to the National Research Ethics Council (**NREC**) in Brazil.

In order for this submission process for ethical analysis was be successful, it was necessary to comply with all requirements that are made by **REC** and **NREC** in the submission of the project through Platform Brazil[4].

> The Platform Brazil is a national and unified database of research records involving human beings for the entire REC / NREC system. It allows the surveys to be monitored in their different stages - from submission to final approval by REC and NREC, when necessary - enabling the follow up of the field phase, the sending of partial reports, and the final research reports (when completed). (Universidade Federal do Espírito Santo, 2020).

After the approval of the research project by **CAT**, it was necessary to create new documents and improve the research project for submission to the **REC** and **NREC**. In this context, the description of these documents and formalities that were necessary for this process are available in the appendix I (pág.175), in addition to the description of the team that participated in supporting this research.

Finally, after being considered, the research received the Certificate of Presentation of Ethical Appreciation (**CPEA**) case number: **03763418.6.0000.5188**, it was appreciated in its methodology and ethical aspects and were approved for its execution, according to the presented planning.

After the completion of all research, data tabulation, and publications, the research coordinator submitted a final report for consideration to the research ethics committee to receive the Negative Certificate. The same also can be found in the appendix II (pág.177).

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[4] The Brazil Platform can be accessed through the following internet address: http://plataformabrasil.saude.gov.br/

Chapter 4 - PROTOTYPE DEVELOPMENT

This chapter covers items such as the conceptual research of the prototype, the description of its characteristics, and the search for similar applications. In addition, it includes technical research and reasoning about the development, and finally, the main elements directly related to the execution of the prototype.

4.1. Conceptual Research

The prototype was developed with contributions from two parallel theoretical frameworks based on preliminary bibliographic research as viewed in the chapter on the literature review: (1) the one related to fundamental components of design, encompassing concepts such as user experience evaluation methods, sketching user experiences, instructional design, user experiences, user interface, theoretical referential works as (Buxton, 2007), (Wiley D. A., 2000), (Greenberg, Carpendale, Marquardt, & Buxton, 2012), (Vermeeren, et al., 2010), (Piskurich, 2015), (Adão & Jacob, 2011); and (2) the one related to the specific pedagogical components for the design of digital learning objects (**DLO**) through works like (Dias, Kemczinski, Lucena, Ferlin, & Hounsell, 2009), (Prata & Nascimento, 2007), (Ghisi, 2016), (Neto, Biagiotti, Baldessar, & Siqueira, 2017), (Nocar, Tang, & Bártek, 2016), (Fuchs, Bruch, & Annegarn-Gläß, 2016), (Galafassi, Gluz, & Galafassi, 2013), (Braga, 2014), (Braga, 2015), (Tarouco, Fabre, & Tamusiunas, 2003), (Tarouco, Ávila, Santos, Bez, & Costa, 2014), (Smith, 2004), (Zuckerman, 2006).

In this way, the goal was to consider both the primordial characteristics for the development of a new tool as digital media, focusing on the identification of the opportunity for innovation and the creation of a new product/functionality; as well as considering the essential characteristics so that this new digital tool can also be useful, recognized and conceptually framed as a **DLO**.

Considering that the purpose of the research was not restricted only to the creation of the tool itself, but also its validation in its technical and pedagogical criteria, the basic elements for its development were from the beginning related to the form of evaluation and validating of the prototype.

After the in-depth study of several works related to the design, production, and evaluation of **DLO**, it was realized that there is no definitive methodology on how to conceive and evaluate a Learning Object (**LO**). A relevant study was done by Neto et al. (Neto, Biagiotti, Baldessar, & Siqueira, 2017) where, through a systematic review of the specialized literature, they presented the main methodologies and instruments for evaluating **LO** found in the **SCOPUS** database, published between 2005 and 2015.

In this comparative study, 34 different methods of analysis of learning objects were included and among these are:

> [...] from evaluations composed of only two criteria (Morgado, Ruiz and Peñalvo, 2007), until evaluations that consider fourteen dimensions (Marzal and Pedrazzi, 2015). Nevertheless, it can be said that in general, the main criteria considered were pedagogical and usability. (Neto, Biagiotti, Baldessar, & Siqueira, 2017).

Based on this study and other work with content related to **LO** evaluation mentioned above, a survey and evaluation of what characteristics each of these methods used in their evaluations was made. The objective was to identify and select the most common characteristics among these already existing and reported assessment methods.

In order to exemplify the wide variety of methods for evaluating learning objects existing, it follows some of the evaluation methods found in the research by Neto et al. (Neto, Biagiotti, Baldessar, & Siqueira, 2017), whose evaluation criteria for each method were studied in order to later choose the most used for this research: Reeves, LORI (Learning Object Review Instrument), MERLOT (Multimedia Educational Resource for Learning and Online Teaching), HEODAR (Herramienta para la Evaluación de Objetos Didácticos de Aprendizaje Reutilizables), Quality Criteria, Elements Determining Quality, BECTA (British Educational Communications Agency), DESIRE (Development of a European Service for Information on Research and Education), LOEM (Learning Object Evaluation Metric), Q4R (Quality for Reuse), Open ECBCheck (E-learning for Capacity Building), QEES, LOQEVAL (Learning Objects Quality Evaluation), TAM (Technology Acceptance Model), LOAM (Learning Object Attribute Metric Tool), LOAM (Learning Object Acceptance Model), Model CIPP (Context, Input, Process, and Product), among others.

After analyzing the most used criteria in these varied learning object assessment methods, it defined 39 characteristics to be used in the design and consequently in the evaluation of the prototype. Of these, 17 are more directly related to fundamental concepts of design and 22 characteristics with concepts of **DLO**.

The following Table 4.1 shows the list of the 39 final attributes with a classification in parentheses to indicate the theoretical reference related to each characteristic. These characteristics had to be constituted in attribute format since these characteristics were designed to be used both in the form of relevance and in the form of adequacy to be applied to the participants.

The difference between the formularies is that the relevance form uses all 39 attributes, while the appropriateness form uses only 16 of these attributes, 8 of which are design fundamentals and 8 are related to the **DLO** design. The reduction for the 16 adequacy attributes was based on the attributes most frequently mentioned in the different methods studied.

The relevance form will have the objective of understanding which attributes will be considered the most relevant for the prototype. The adequacy form will have the objective of understanding which attributes will be considered the most suitable, that best fit the prototype. The ranking of the attributes will reveal how the tool is analyzed by the participants, and the difference between both formularies can bring information about the attributes to be better worked, because not always those that are considered most relevant are the ones that best suit the product.

Table 4.1 - Main theoretical references selected to guide prototype development and future evaluation and validation

Attributes - Description (Main Theoretical References)
Accessibility[5] - internet dependence; accessible by any browser and operating system.* (DB-UI)
Reuse - reusable in different contexts of teaching and audiovisual production, serving as a reference for other teachers. (DB-UI; LO-GA)
Pedagogical relevance - appropriate and relevant in the educational context in which it is included. (LO-GA)
Adaptability - navigation options to fit the needs of the student, making it use intuitively. (DB-UI)
Aesthetics - layout, and choice of elements such as texts, links, images, videos. Considering the limitations on forms.* (DB-UI)
Comfort - a perception of a comfortable feeling while using the tool.* (DB-UI; DB-Erg)
Utility - a perception that the use of the tool is valid.* (DB-UI; DB-Erg; DB-UX)
Organization - a perception of organization (way of navigation and subdivision in stages).* (DB-UI; DB-Erg)
Supporting documentation - information about the tool. Contained in it and in the site related to the doctoral research and the tool.* (DB-UI; DB-Erg)
Technical functionality - if it fulfills its purposes: assistance in data collection and automation in the transfer of these to CGI software.* (DB-UI; DB-UX; DB-Usb)
Ease of use - a perception of ease of use of the tool.* (DB-UI; DB-UX; DB-Usb)
Self-explanatory - self-explanatory capacity perception during its use. (DB-UI; DB-UX; DB-Usb)
Error messages - when they occur clearly identify the error that is occurring and presents a solution to it. (DB-UI; DB-UX; DB-Usb)
Efficiency - a perception of being competent, productive, of achieving the best yield with the minimum of errors and/or expenditures. (DB-UI; DB-UX; DB-Usb)
Convenience - a perception that it can be used to uncomplicate a routine; which can bring advantages to the person using it. (DB-UX)
Economic value (cost) - free. (DB-UX)
Satisfaction - contentment, pleasure arising from the accomplishment of what is expected, of what is desired in the use of the tool. (DB-UX)
Interactivity - allows the individual to interact by making it possible to choose which data and information the user want to collect or have access to. (DB-UI)
Collaborative learning - enables the partnership between students/users to better perform activities. (LO-GA)
Pedagogical objectives - identifiable and appropriate to the target audience. Assistance in the practical activities of audiovisual production with the interaction between real and virtual images.* (LO-LA)
Language - favors understanding and learning. (LO-LA)
Challenging - it brings forth, instigates, provokes a confrontation, puts itself to the test. (LO-LA)
Feedback - received by the teacher during the execution of the activities was important for the use of the tool and understanding of the related content. (LO-LA)
Autonomy - allows students to carry out activities without teacher intervention, encouraging exploration and involvement.* (LO-LA)
Content - addressed in a clear and precise manner, with adequacy and consistency to the target audience. It hasn't omissions or prejudice. (LO-LA; LO-P)
Pedagogical appropriateness - presents conformity to the educational context in which it is inserted.* (LO-GA)
Active Learning - Leads the student from the passive listener role to an active learner who builds their knowledge (learning to learn). (LO-P)
Motivation - a set of processes that give the behavior an intensity, a direction determined during the use of the tool.* (LO-M)
Quantity of information - enough and not excessive. (LO-GA)

[5] The accessibility attribute must be considered not only in the understanding of its meaning in which it appears in the table, relative to the technical issue of being accessible by a particular browser or operating system but also in the understanding of assisting people with disabilities (hearing, visual, motor, etc.).

Coherence - logic, meaning between the contents, the objectives, the activities developed, the evaluation and the profile of the student. (LO-SLO)
Playfulness - a perception that the use of the tool is pleasant, fun. (LO-P)
Instructional structure of orientation to the student - quality and sufficiency of the instructional contents in the website of the tool. (LO-P)
Help in learning - provided by the tool as an educational resource (learning object).* (LO-P)
Instructional structure of orientation to the teacher - quality and sufficiency of the instructional contents in the website of the tool. (LO-P)
Metadata - present on the tool's website in accordance with the standardization of Learning Objects repositories.* (LO-P)
Medium level of requirement - the demands necessary for the student to access, interpret and process the instructions of the tool and make use of it. (LO-GA)
Content quality - concepts, information, references, images, etc. used in the tool (reinforce key points and significant ideas).* (LO-TA; LO-P)
Multimodal text - when integrating text and image or text and video into the necessary moments for a better understanding of the concept to the user. (LO-P)
Language (idiom) - English language, international use, majority use in the CGI and audiovisual software area.* (LO-LA)

Table 4.2 - Legend - Main Theoretical References of Attributes of Table 4.1

DB-UI	Design Basics - User Interface
DB-UX	Design Basics - User Experience
DB-Erg	Design Basics - Ergonomics
DB-Usb	Design Basics - Usability
LO-GA	Learning Object - General Aspects
LO-LA	Learning Object - Learning Assessment
LO-P	Learning Object - Psychopedagogy
LO-M	Learning Object - Motivation
LO-SLO	Learning Object - Adequacy of Learning Objectives
LO-TA	Learning Object - Teaching Assessment
*	Attributes selected for Adequacy Form

The explanation of the attributes used, therefore, serves to define methodologically the design, technical and pedagogical qualities, fundamental for the prototype design process and later to proceed with its evaluation and validation.

4.2. Description of the tool characteristics

For a more tangible overview of the tool to be developed, it can be described as follows. It will be an application that, in the first place, will help the teacher to better transmit the theoretical and practical concepts in the pedagogical act. In the second place, it will assist the student in the execution of audiovisual products that require interaction between real and virtual images.

The tool will allow the user to select the number of technical elements to be used in the scene to be filmed and to have data collected, considering that the quantity and type of these elements may vary depending on the type of visual effect to be performed, thus offering, the necessary fields to record this data. The collected data will be used later when composing the 3d (virtual) universe with the actual images already captured.

During the interactions between the application and the user, the program will present static or moving images to better illustrate the technical/theoretical issues that must be registered. That is, the program will not have the function of visually stimulating three-dimensional information that it is helping to collect, however, it will present, when necessary, images to help in understanding the technical context during its use. It will, therefore, include an elementary way of simulating the content involved, so that, in addition to helping with production, it also presents a pedagogical bias for understanding the content.

After its use, the tool allows issuing a report with the relevant information collected so that this data can be used in the construction of the virtual environment according to the technical specificities of the actually filmed environment. In addition to this functionality, during the development of the tool, the possibility of using some programming language will be evaluated so that the program can also export this data in a script so that the computer graphics software can import the collected data. This allows to create, position and configure some elements of the virtual world in accordance with the data collected from the real work, streamlining this work and being able to generate some productivity gain.

As an example, we can consider a user with the intention of filming a real environment and inserting a virtual object or character in this scenario for interaction between both.

In this case, the use of the tool, helps, alerting, and collecting the main notes to be made, such as data on spatial location and technical parameters of the camera, lights, and objects of the scenario that will interact with the virtual object/character. Also, the user can at the end of the filming process aided by the application, generate a data report and a script for the computer graphics software, providing the collected information, later facilitating the virtual production stage (3d) and the interaction with the respective filmed images.

4.3. Prototype definitions, search for similar, and originality

This section presents the definition of the prototype and its characteristics, provides information on the search for similar tools, and present comments about its originality.

Prototype definitions

Starting from the idea of developing a digital learning object (**DLO**) to aid in the practical learning activities mentioned above, initial research was carried out in search of some existing tool with the functionality close to that desired by the prototype to be created.

For this, the prototype had to be minimally defined in relation to its objectives:

a) To assist in the indispensable collection of data for later reconstruction of the real characteristics in the three-dimensional virtual environment (computer graphics software).
b) To prevent essential and important information from being forgotten.
c) To create a methodology for collecting the data in order to organize it.
d) If possible, to automate part of the task of reconstructing the virtual environment from the actual data collected, using programming so that from the data collected, it is possible to generate a script for the automation of the creation and configuration of the virtual elements.

Definition of tool features

The main characteristics of the design of the prototype were as follows:

1) Previous tips on measuring instruments.
2) Data collection from cameras (legacy and physical).
3) Data collection about natural light.
4) Data collection about artificial lights (standard and photometric).
5) Data collection about reference objects (reference balls, plans, reference rod).
6) Alert for other important references (color checkers, references for camera trackers, creation of photos, or film in 360 degrees for reflections).
7) Data collection for render setup.
8) Capability to utilize the data collected to automate the process of reconstruction of the real elements into virtual ones in the computer graphic image (**CGI**) software.

Search for similar tools

After this guiding definition, research was performed for computer software (Windows, Linux and Mac operating systems), Applications for mobile devices (in apps distribution stores such as Google Play, App Store, Amazon Appstore, Uptodown, Aptoide, APKPure, F -Droid, Uptodown), and online tools (websites) that could offer the same solutions.

No software, app, or website was found with the characteristics listed. The closest application that, however, does not specifically meet the listed goals was the "Shot Designer" App available for Mac / PC / iOS / Android. This application allows collecting several data during the filming, besides having several and relevant other functions, however, it is not directly oriented to the production of **VFX** and Match Moving. In addition, it does not offer the function of automating part of the work of rebuilding the real environment for the computing graphics imaging (**CGI**) software.

Originality

This research validated the originality and innovative aspect of the prototype to be developed, by confirming, as much as possible, that there are not available any other applications that minimally meet the demands that the prototype intends to offer.

4.4. Technical research

Technical research is conceptualized as being part of the research focused on which technologies to adopt for the practical execution of the prototype.

4.4.1. Prototyping Platforms

Preliminary research was carried out in search of prototyping platforms (sketch and model), where it is possible to program and design applications for mobile devices without the need to fully program, in addition to also making it possible to test them on various mobile devices and send them to app distribution stores like Google Play and App Store.

Some of these platforms tested, with respect to technical resources, ease of use, difficulties, limitations, price of use, among other factors were:

- InVision
- Prott
- Mockup.io
- JustInMind
- Mobincube
- Appy Pie
- OutSystems
- AppSheet
- GoodBarber
- AppMakr
- Axure
- Instappy
- Sketch

In addition to these platforms with complete solutions, other large corporations' platforms were also researched for the creation and prototyping such as:

- Google App Maker (with G Suite for Education – Google Apps)
- Visual Studio LightSwitch (Microsoft)
- PowerApps (Microsoft Office 365)

The great potential of these platforms that present integrated solutions is that they foster what Tarouco et al. mention:

> Authoring tools are essential resources for teachers to develop digital pedagogical content without the need to know a specific programming language. (Tarouco, Ávila, Santos, Bez, & Costa, 2014).
>
> The evolution of authoring tools has contributed to a new scenario in which the production of digital educational material has been less and less restricted to the group of programming and design experts. Tools that provide the addition of interactivity and multimedia resources to digital content, without the need for programming, have provided the teacher with a new panorama, in which he sees himself not only as a user but also as a professional able to prepare their own Learning Objects. (Tarouco, Ávila, Santos, Bez, & Costa, 2014).

The research was based on finding a way to enable the prototype with the envisioned characteristics but through a simpler process, considering the concept of a **DLO** as defined by Wiley (2000), Tarouco, Fabre and Tamusiunas (2003) and IEEE in Braga (2014) there is a concern that it can be used by other teachers (use and reuse/reusability). It should also serve as a reference so that other educators can also design their own **DLO** suited to their needs. In this context, choosing open-source technology and good accessibility meets these properties.

This preliminary research, where all these platforms were tested, getting in each of them, knowing their potential, limitations, costs, and resources, took months of research since the intention was to search for the tool(s) that could be configured in order to solve and meet most of the requirements of the prototype.

A more detailed description of all these tests developed will not be presented because it is believed that it is more important the presentation of the final solution found. However, it is relevant to emphasize the importance of all these incursions, comparisons, and tests that were performed, to emphasize that the solution found, although it seems simple at the end, was carefully researched.

The solution chosen was to use the technologies available through Google Forms and Spreadsheets and in an integrated way, to complement and make feasible the programming of the functionalities, the use of two add-ons developed by CloudLab - Part of New Visions for Public Schools, which are the "autoCrat" and "copyDown".

Through several technical tests, it was possible to conclude that with the integration of these tools it would be possible to meet all the characteristics of the **DLO**. In addition, the programming part for the generation of the automation function could be developed through automation using form formulas, not needing to learn a new programming language.

4.4.2.CGI software and programing language

There is currently several professional **CGI** software solutions to produce animation and three-dimensional graphics computing. Some examples used in the entertainment industry for animations and visual effects are Maya, Houdini, Cinema 4D, Softimage, Lightwave, Pixar RenderMan, 3D Studio Max, Blender.

Many of these solutions have their own programming language usually known as scripts, which allow automation through command lines or programming environments. Some examples of these computer languages are:

- **Maya Embedded Language** (MEL) used in Maya software.
- **HSchipt** used in Houdini software.
- **COFFEE** used in Cinema 4D software.
- **LScript** used in Lightwave software.
- **MAXScript** used in 3ds Max®.
- **Python** used in Softimage, Blender and accepted in Houdini and Maya software.

In this context, to be able to execute the said automation characteristic by the prototype, it was necessary to choose one of these solutions and its respective programming language. In this process of choice, although the Python language is interesting because it is accepted by several **CGI** software solutions, the previous experience in the use of the software 3ds Max®, led to its choice together with the **MAXScript** language.

It is important to note that in addition to creating a script for automation in the use of the chosen software, all the data collected by the tool is also made available to the user of the tool so that it can be used in any other **CGI** software manually.

4.4.3.Definition of the variables to be used

Having defined the technologies to be used in the prototype, a study was carried out to select the variables to be used in the tool. As an example, we can mention that in the standard lights, from 47 possible attributes for their creation and configuration, 11 were selected for use in the tool, in addition to the positioning and name data, reaching 15 attributes. Next, Figure 4.1 illustrates some of these selected attributes.

Technical choice of the elements to be used in the tool.

Standard Lights: 5 types of lights chosen from 6;

41 common attributes + 6 attributes not common to only 1 of the light types.

.type	.enabled	.excludeList	.includeList	.inclExclType
.castShadows	.rgb	.hsv	.hue	.saturation
.value	.multiplier	.contrast	.softenDiffuseEdge	.affectDiffuse
.affectSpecular	.ambientOnly	.projector	.projectorMap	.useShadowProjectorMap
.nearAttenStart	.nearAttenEnd	.useNearAtten	.showNearAtten	.farAttenStart
.farAttenEnd	.useFarAtten	.showFarAtten	.attenDecay	.decayRadius
.useGlobalShadowSettings	.raytracedShadowns	.shadowGenerator	.shadowColor	.shadowMultiplier
.shadowProjectorMap	.twoSidedShadows	.lightAffectsShadow	.atmosShadows	.atmosOpacity
.atmosColorAmt	**.aspect**	**.falloff**	**.showCone**	**.hotspot**
			.overShoot	**.coneshape**

Figure 4.1 - Attribute selection for standard lights

In the Physical Camera, out of a total of 77 possible attributes (18 in common with other types of camera added to another 59 specific attributes) were chosen 21 of these attributes, plus name, position, and angle of inclination, reaching 28 attributes.

In this way, all the principal elements of the tool went through a selection of the most relevant attributes (variables) to be used.

For this selection, in the first moment, the essential attributes for the correct configuration of the element were prioritized, so that it could present the same characteristics of the real elements present in the moment of shooting the film.

In the second filtering, certain internal configurations of the **CGI** software were selected that could also facilitate the representation of certain physical (real) characteristics of the elements. The attributes related to more specialized and refined configurations, whose function is more relevant in use in later stages, were left out.

It is important to note that the bibliographic work VES (VES - Visual Effects Society, 2010, pp. 204 - 205) was used as a reference in helping to build some of the available fields (many optional) for the collection of scene data in the tool. Figures 10.1 and 10.2 on pages 204 and 205 were used to analyze which fields could be useful in the prototype in order to make it as complete as possible. In this way, it can professionally serve to enthusiasts, because it is close to a more professional application. Moreover, use of these terms and technical elements also contributes to the qualification of students using the tool in an educational environment.

Other important elements/variables that should and were included in the research project, but not necessarily directly in the prototype itself, were related to information related to **DLO**s such as metadata and elements of the instructional structure.

Such data must be available to users so that it can help both students and teachers to better understand the tool in their educational context as an object of digital learning.

In order to contemplate these elements, they were all included and are available on the website related to this doctoral research that hosts the tool, in addition to notation within the tool itself about the availability of this information through a link to access the site and the respective data on the first page of the prototype.

4.4.4. Definition of the number of elements that the prototype will support

In the end, the tool provides, in general, the following data collection options for the scene to be filmed (each of which consists of many data entry fields):

- Shot location information.
- Visual effects information.
- Camera data collection (limit of 3 cameras at the same time in a scene, choices between legacy or physical type).
- Lighting data collection (natural and/or artificial) (limit of 1 natural light in a scene and 8 artificial lights, limited of 4 lights that each type - standard or photometric).
- Data relating to reference objects (reference balls for incidence light angle and color of light; reference plane to the place that will receive shadows and reflections from virtual 3d object or character; reference rod for size proportions and shadows).
- Reminders about other important types of reference instruments (and images/film to be produced for specific situations) (color checkers, chroma-key references for camera trackers and the creation of photos or film in 360º for reflections).
- Data collection for render setup.
- Presets for 3ds Max® File.

At the end of the prototype production, after the effective tests, **a total of 319 fields** were used between the necessary fields to meet the attributes of all possible inputs of all possible elements, in addition to the fields required for navigability and programming.

The lights are divided into the following categories:

- Natural Light (it is possible to collect data of only 1 light of this type).
- Standard Lights (it is possible to collect data of up to 4 lights of this type).
- Photometric Lights (it is possible to collect data of up to 4 lights of this type).

The next table (Table 4.3) shows the types of lights within each of the categories.

Table 4.3 - The types of lights within each category

Natural Light:	**Standard Lights:** (Free or Target)	**Photometric Lights:** (Free or Target)
Day Light	Directional Light	Free Point
	Free Spot	Free Linear
	Omni Light	Free Area
	Target Spot	Free Disc
	Target Directional Light	Free Sphere
		Free Cylinder
		Target Point
		Target Linear
		Target Area
		Target Disc
		Target Sphere
		Target Cylinder

4.5. Technical Execution

To assist in the implementation of the prototype, items such as navigability, freedom, and technical limitations, elements of support, language, license, tests, website, and repositories of learning objects were conceptualized, discussed, and used.

4.5.1.Technical freedoms and limitations of the project

The technical choice of the digital tools for development presented, like any other possible option, has positive and negative points.

Some of the positive points were:

a) the tools are all freely accessible, thus highlighting the possibility of developing DLOs through affordable and zero-cost technologies, encouraging other teachers to create their own tools to aid in their teaching and learning activities.

b) it can be considered as open source since the researcher gives full permission to the visualization of the formulas used to program the prototype so that other teachers can adapt the solution found to their own needs.

c) the solution does not use any programming language advanced beyond the **MAXScript** of the software 3ds Max®, because, for the representation of the collected data and its automation for the creation of Script, only spreadsheet formulas were used.

d) the technology chosen for designing the prototype allows it to be used in any device and operating system, in both computers and mobile devices, making it very accessible and adaptable, important characteristics/attributes to be considered in **DLO**s projects as already described in the literature review.

Some of the negative points were:

a) design limitations because the use of Google Forms for data collection implied technical limitations in the possibilities of layout configurations, navigability, among others.

b) technological dependence of companies that provide the technologies, because, despite the use through login and Google account, the company can change some feature or discontinue some function without prior notice and compromise the resources already implemented.

c) despite the practicality and adaptability of being an online tool that can be used in any web browser including mobile devices of any operating system, it is needed the device to have an internet connection to work. That is, you cannot use the device offline, compromising its use in remote locations, or without a data connection.

Layout limitations caused design tests (layout, ergonomics, usability) to be suppressed because the development did not have the aesthetic and functional freedom of an application created from scratch.

Despite these limitations, the tools chosen and used still presented great possibilities for creating, personalizing, and configuring elements that assisted in the construction of the prototype to achieve its objectives.

Support elements further explained in item 4.5.6, exemplify how much it was possible and feasible to transform the form into a tool that aggregates elements that contribute very positively to the process of understanding the concepts and technics related to the field.

One of the technical limitations found due to the limitations of the **MAXScript** programming language, was the impossibility of reconstructing via script the parameters related to the creation of natural light within the 3ds Max® software. That is, there is the possibility of creating a natural light by choosing between the options of existing types, however, it is not possible to configure its various parameters.

To get around this limitation for the prototype user, the developed solution was to collect all the necessary parameters during the filming and use of the tool. After the collection step, and through the created script, to present an alert screen (Figure 4.2) already inside the CGI software, with all the information collected.

This alert screen advising the user to copy the contents of the window so that they can later transpose this data to the tab already open in the 3ds Max® software (Figure 4.2) where the fields for entering this data are.

This way, making it easier for the user to transpose all these data collected to the correct place in the CGI software, right after the script execution ends.

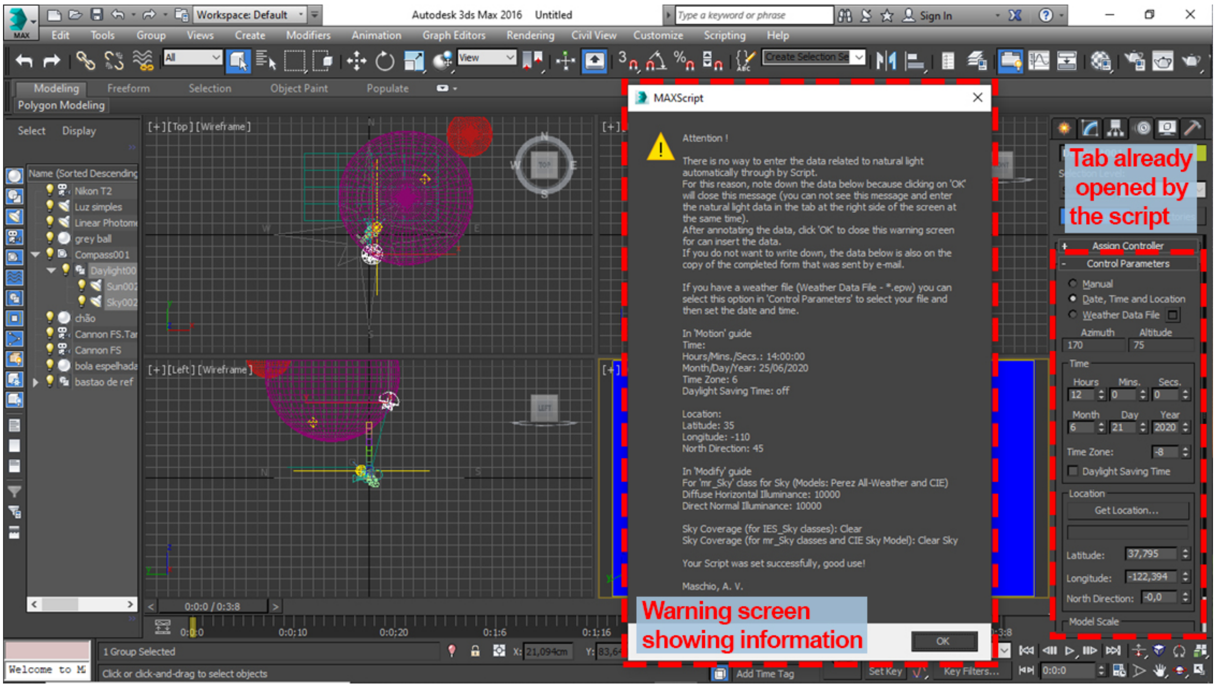


Figure 4.2 - An example of how the collected natural light data is presented to the user, as well as the automated opening of the window where the fields for inserting said data are located

4.5.2. Units of measure

At this stage, there was a need for an in-depth study about the measurement conversion programming possibilities, and if it would be interesting and feasible to allow a choice between certain units to be used during the data collection data and later with the **MAXScript** programming language. However, the technical research together with tests on the possibilities with the **MAXScript** language showed the existence of certain limitations.

For example, although it is possible to configure the unit of measurement between Generic (inches), Metric (centimeters), US (Feet 1/32), Custom (Feet), to be used and displayed within the software, all programming via **MAXScript** works just using the Generic (inches) unit. Therefore, for this type of unit, if the possibility of entering another unit was made available, it should be converted before the value is used in the Script programming.

Due to the unfriendly interface of the spreadsheet formulas for the proper programming of such conversions, and the need for multiple input fields for such conversions in the spreadsheet, it was decided to adopt the Generic unit as a unit of measurement.

This choice aimed to avoid greater complexity in automatic spreadsheet calculations, excessive input fields (just to configure conversions) in order to make the layout tiring to fill, in addition to seeking to reduce the possibility of errors in the formulas.

It is worth mentioning that although data insertion in the prototype has to be done in inches (for correct automated creation of the script), in the last fields of data collection it is possible to choose between the other measurement units so that the script leaves the CGI software configured in the chosen unit of measurement.

That is, although all creation of the elements of the scene must be in inches, it is possible to change the unit of measurement used within the software at the end of the script.

Another example of choosing a unit of measurement is related to the Field of View (FOV). In this case, although inside the **CGI** software it is possible to choose to enter the data between vertically or diagonally degrees, or even in “mm”, using Script it is only possible to enter the value through horizontal direction degrees. To assist in this step, a link to an external conversion tool was made available as a support element (item 4.5.6), where it is possible to convert/calculate from “mm” to horizontal degrees.

FOV
Determines how wide an area the camera views (field of view). When FOV Direction is horizontal (the default), the FOV parameter directly sets the arc of the camera's horizon, measured in degrees. You can also set the FOV Direction to measure FOV vertically or diagonally inside the software, not here to script creation.
Field of View (FOV) *
Input the data "Angle of view" (deg) in horizontal direction degrees, not in vertically or diagonally degrees, and also not in (mm) "Lens Focal Length". If you don't know how to convert/calculate from mm to horizontal degrees, look up this option:
https://www.scantips.com/lights/fieldofview.html#top

Another unit of measurement in which the same technical factor occurred was the unit of measure of luminosity intensity. Although the **CGI** software allows the three most common units (Lumens, Candela and Lux) to be used within it, through **MAXScript** it is only possible to make configurations using the unit in Lumens.

Therefore, in order to facilitate and avoid the same inconveniences previously reported, external options for conversion tools from Lux to Lumens, Candela to Lumens, Candela to Lux, and Watts to Lumens were presented, as can be seen in the figure below.

Unit of measure of luminous intensity

There are several types of units of measure of luminosity, the three most used are Lumens, Candela and Lux.
In this tool the unit used is Lumens, so if you are performing the measurement using another unit, you can convert it using, for example, the following suggested sites below.

Lux to lumens -> (https://www.rapidtables.com/calc/light/lux-to-lumen-calculator.html)
Candela to lumens -> (https://www.rapidtables.com/calc/light/candela-to-lumen-calculator.html)

If you do not know what the "apex angle in degrees" to convert directly Candela to Lumens you can convert Candela to Lux and then Lux to Lumens, using only the distance from the light point to the measuring device.
Candela to lux -> (https://www.rapidtables.com/calc/light/candela-to-lux-calculator.html)

If you do not have a device for measuring the luminous intensity you can try to obtain a value by calculating as from the power in watts (knowing the type of light).
Watts to lumens -> (https://www.rapidtables.com/calc/light/watt-to-lumen-calculator.html)

4.5.3.Language

Field research was designed for execution at a Brazilian university, mainly due to the following factors:

a) technical availability for the execution of the activities (infrastructure with filming equipment, audio capture, computers for editing and composition of the material, audio studio and video, classrooms), with the necessary control of the variables (laboratory with equipment with the same configuration in hardware and software and time available to render the images outside the class hours).

b) the university provides three undergraduate courses related to audiovisual production (Cinema and Audiovisual course, Radio and TV course and Digital Media Communication course), thus increasing the possibility of a sufficient number of participants in the mini-course / activity of research.

Because of the frequent use of the English language in audiovisual production software, in the **CGI** software and in the manuals and configuration menus for the most varied audiovisual production equipment, already exists a great familiarity of higher education students with this idiom (whether in Brazil or Portugal).

In addition, as it is the most widely used language internationally, it was preferred to be adopted in the prototype, as it will allow its dissemination and use in an international context, and not only in lusophone countries.

4.5.4.Model

Modeling of software using Unified Modeling Language™ (UML®) diagrams is very useful when designing a prototype.

> UML is a common language for business analysts, software architects and developers used to describe, specify, design, and document existing or new business processes, structure and behavior of artifacts of software systems.
> UML can be applied to diverse application domains (e.g., banking, finance, internet, aerospace, healthcare, etc.) It can be used with all major object and component software development methods and for various implementation platforms. (uml-diagrams.org, 2020).

For the thesis, the Violet UML Editor[6] was used in the initial stages of the project because it had already been in contact with the aforementioned editor during the Ph.D. courses mentioned above. However, for the elaboration of the most finished versions of the diagrams produced to aid in the project, Microsoft Visio was used. A good reference for consulting the use of UML diagrams is found in the works of García-Holgado, García, Vázquez-Ingelmo, and García-Peñalvo, from the Department of Informatics and Automation at the University of Salamanca (UML. Unified Modeling Language, 2018) .

A total of four **UML** Diagrams were produced to assist in the execution of the project. Two Activity Diagram and two Use Case Diagram. The two models used are classified as dynamic visualization because they show scenarios, that is, you can see how the entities work, not just how they are made. Below a brief description of the modes:

> Use Case Diagram: The use case diagram represents what your system should do. It is the first diagram you make when you start a project. It will help you to clarify and identity actors (end-user, external systems, etc...) and all your system features. At this stage, you do not think in terms of implementation.

[6] Available in: http://alexdp.free.fr/violetumleditor/page.php

Activity Diagram: The activity diagram is a very old diagram. It is a kind of flow diagram with branches and conditions. It is very easy to understand by end-users. So, it is one of the most important UML diagrams. (Horstmann & Pellegrin, 2017).

The following are the diagrams produced to aid in discussions, reflections, and test execution and definition of the final prototype layout. Such diagrams being relatively large, we chose to make them available in the appendices (page 178) of the thesis instead of being in the body of the text.

UML – Use Case Diagram – Methodology (page 178)

This diagram presents in a simplified way the methodological path that will be executed for the application both of the Research Forms with the participants of the mini-course and the blind analysis with the external evaluators on the products produced during the mini-course.

UML – Use Case Diagram – General problem (page 179)

This diagram presents the problem in general and how the tool intends to solve it. It is possible to visualize in a brief way that the tool will assist in data collection to avoid error that will prevent the activity to be carried out.

UML – Activity Diagram – General solution (page 180)

The diagram of the General Solution divides the steps to be performed by both the user and the prototype developer, to facilitate the understanding of the resources used in its construction. This diagram is divided into the following steps: “Need”, “Where to find the tool”, “Data collection with the tool”, “Sending the collected data and generating and sending the script (MAXScript)”, “The final use of the data collected and generated by the tool”.

It is worth mentioning that depending on the software that the user prefers, except the one for which the tool already produces the script, in many cases it is possible, after executing the script in 3ds Max® software, to export the entire scene with the elements already created and automatically configured in a new file format (different file extension) and therefore be able to use everything that was created by the script within 3ds Max® to another application (if the chosen application support any of the file extensions to export available).

UML – Activity Diagram – Tool (page 181)

This diagram contributes to the visualization of the entire route and navigation within the tool, making it possible to clearly see how it was designed and how navigation occurs during its use.

Below you can see a list of the elements that make up the prototype, however through this **UML** Diagram it is possible to understand exactly what is possible during the navigation, and in what order.

Tool Elements

1. VFX Tool for 3ds Max®
2. Measuring instruments helpful in data collection
3. Shot Location Information
4. Visual Effects Information

5. Camera Data Collection
6. Camera data 1 (Legacy)
7. Camera data 1 (Physical)
8. Camera data 2 (Legacy)
9. Camera data 2 (Physical)
10. Camera data 3 (Legacy)
11. Camera data 3 (Physical)
12. Lights
13. Lighting Data Collection
14. Natural Light
15. Artificial Lights
16. Standard Light 01
17. Standard Light 02
18. Standard Light 03
19. Standard Light 04
20. Photometric Light 01
21. Photometric Light 02
22. Photometric Light 03
23. Photometric Light 04
24. Reference Objects
25. Reference Balls
26. Reference Balls Data Collection
27. Data Collection for a Plan
28. Data Collection for a Reference Plane
29. Data Collection for Reference Rod
30. Reference Rod Data Collection
31. Alert for other important references
32. Data Collection for Render Setup
33. Presets for 3ds Max® File
34. Finish

The production of this diagram, in parallel to numerous navigability tests through the options available through Google Forms and addons made possible better planning and execution of the entire design part of the prototype, both in relation to the order of presentation of the elements, the screens containing explanations, tips, and observations, support elements, routes for the task of data collection, navigability and usability of the tool, offering support for the tests and definition of the final layout.

4.5.5.Script programming formulas

This section seeks to display one of the spreadsheet formulas used in the tool for its programming. The formulas used are the same used in other software such as Microsoft Excel (Microsoft Office package) or Libre Calc (Libre Office package).

As previously described, the option for a technical strategy that is easier to execute, without the need to learn a new programming language (besides the one related to the **CGI** software for creating the Script) aimed to facilitate the implementation of the prototype, as well as serve as encouraging other teachers to create their own relatively complex **DLO**s using accessible, free and open-source tools.

The following is an example of one of the formulas (programming) used in the spreadsheet to generate the script. The formula has been formatted to improve your understanding (it is commonly used without line breaks).

The main formula for Physical Cameras.

```
=SE(BB2=0;"";

SE(BB2="off";
CONCATENAR("Physical targeted:off ";WZ2;" name:""";AB2;"""";" focal_length_mm:";AH2;"
zoom_factor:";AJ2;" f_number:";AI2;" use_dof:";AK2;" show_camera_cone:";XF2;"
motion_blur_enabled:";AL2;" target_distance:";BC2;" horizon_on:";AN2;" ";XC2;"
environment_near:";AT2;" environment_far:";AU2;" clip_on:";AQ2;" clip_near:";AR2;" clip_far:";AS2;"
specify_focus:";XI2;" focus_distance:";BE2;" pos:[";AV2;",";AW2;",";AX2;"] isSelected:on";
CARACT(10);"rotate $ (angleaxis 90 [1,0,0])";
CARACT(10);"rotate $ (angleaxis ";AY2;" [1,0,0])";
CARACT(10);"rotate $ (angleaxis ";AZ2;" [0,1,0])";
CARACT(10);"rotate $ (angleaxis ";BA2;" [0,0,1])";
CARACT(10));

SE(BB2="on";
CONCATENAR("Physical targeted:off ";WZ2;" name:""";AB2;"""";" focal_length_mm:";AH2;"
zoom_factor:";AJ2;" f_number:";AI2;" use_dof:";AK2;" show_camera_cone:";XF2;"
motion_blur_enabled:";AL2;" target_distance:";BC2;" horizon_on:";AN2;" ";XC2;"
environment_near:";AT2;" environment_far:";AU2;" clip_on:";AQ2;" clip_near:";AR2;" clip_far:";AS2;"
specify_focus:";XI2;" focus_distance:";BE2;" pos:[";AV2;",";AW2;",";AX2;"] isSelected:on";
CARACT(10); "$.targeted=on";
CARACT(10);"$";AB2;".Target'.pos=[";XX2;",";TT2;",";QQ2;"]";
CARACT(10);"rotate $ (angleaxis ";AZ2;" [0,1,0])";
CARACT(10);))))
```

In the example above, if the BB2 field has not been filled out, the formula will not write anything on the lines of the script to be created.

If the field is filled with the term "off" it means that the camera selected for creation will not have a target, so it will have different writing than if the field was filled with the term "on", which signals the use of a target to the camera.

Below are two examples of physical camera creation scripts, one without and one with a target, to compare the programming with the result.

The command "CARACT (10)" for example, is used to make a line break when writing the script; and the “CONCATENAR” command to write a line joining textual elements and data collected by the spreadsheet available in the file/table.

Physical Free

```
Physical targeted:off exposure_value:6 film_preset:"Custom" film_width_mm:22.9 name:"Red Digital
Camera" focal_length_mm:40  fov:38.1323 zoom_factor:1.00 f_number:8.07919 use_dof:off
show_camera_cone:0 motion_blur_enabled:off target_distance:196.85 horizon_on:off
white_balance_illuminant:20 white_balance_kelvin:6763.93 environment_near:0
environment_far:39370.1 clip_on:off clip_near:0 clip_far:39370.1 specify_focus:0
focus_distance:196.85 pos:[0,0,0] isSelected:on
rotate $ (angleaxis 90 [1,0,0])
rotate $ (angleaxis -15 [1,0,0])
rotate $ (angleaxis 25 [0,1,0])
rotate $ (angleaxis -18.5031 [0,0,1])
```

Physical Target

```
Physical targeted:off exposure_value:6 film_preset:"Custom" film_width_mm:22.9 name:"Sony Alpha Camera" focal_length_mm:40  fov:38.1323 zoom_factor:1.00 f_number:8.07919 use_dof:off show_camera_cone:0 motion_blur_enabled:off target_distance:196.85 horizon_on:off white_balance_illuminant:20 white_balance_kelvin:6763.93 environment_near:0 environment_far:39370.1 clip_on:off clip_near:0 clip_far:39370.1 specify_focus:0 focus_distance:196.85 pos:[0,0,0] isSelected:on
$.targeted = on
$'Sony Alpha Camera'.pos = [184.978,371.451,-177.118]
rotate $ (angleaxis 25 [0,1,0])
```

As many formulas have been created to deal with the 319 existing fields in the prototype, it is impossible to display them all in the body of the text. However, they are available in the appendix on page 185.

4.5.6.Support elements

The first support elements provided in the tool are optional as they are a presentation of some measuring instruments that can be very useful during the data collection to produce **VFX**.

Right on the first page of the application, the user is given the option to proceed to this other page to view some examples, as can be seen in the Figure 4.3 below.

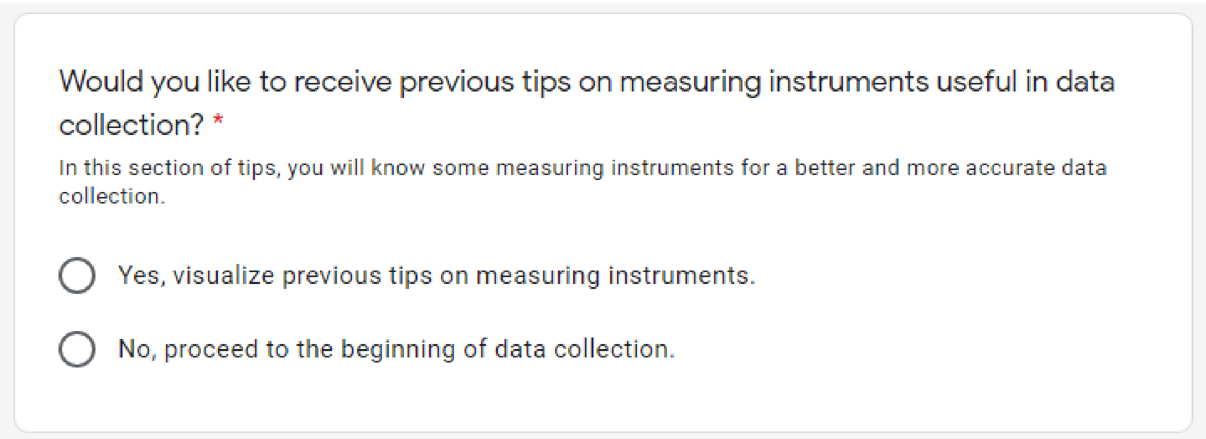


Figure 4.3 - Seeing tips on useful measuring instruments for data collection

This section presents several images and explanations of measuring instruments such as: Photometer, Light Meter, Exposure Meter, Lux Meter, Color Meter, Measuring Tapes, Laser Rangefinder, Rotary Laser Level and Total Station. This section can be seen right at the beginning of the tool, available in the appendix from page 204 of this thesis.

To complement the tool functionalities, some animations and static images were produced to assist in the understanding of some concepts. Some of these were collected on the web attributing the credits.

Hyperlinks were also used to websites with more detailed technical explanations of certain concepts, and access to online tools to assist in specific calculations in the audiovisual area, such as unit conversion tools (lux, lumens, candela, watts) or for calculating the field of view (FOV) of the camera, for instance.

Some of these supporting elements will be shown with some illustrations that follow so that it is possible to understand some of these pedagogical and technical resources used to complement the application. Below, the first alert that is made available when the application starts.

Alerts

1) While inserting the data do not use the plus sign (+) to indicate that a number is positive. Besides being unnecessary, it will cause errors in the script that will be created. Use the number without any signal to indicate that it is positive, and only use the minus sign (-) when indicating a negative number, no problem in this case.

2) Define your own zero coordinates in the 3 axes (x,y,z) and collecting the data of the spatial position for the objects (cameras, lights, targets, reference objects, etc.) is one of the biggest challenges on the set.

In case of inexperience, the exhaustive training of this type of execution becomes indispensable and vital to that the data collection is done correctly and there are no future problems in the execution of the visual effects.

In the case below, the support element, in addition to alerting the unit in which the data should be collected, also has an external link, where it is possible to make conversion calculations for the necessary unit.

FOV

Determines how wide an area the camera views (field of view). When FOV Direction is horizontal (the default), the FOV parameter directly sets the arc of the camera's horizon, measured in degrees. You can also set the FOV Direction to measure FOV vertically or diagonally inside the software, not here to script creation.

Field of View (FOV)

Input the data "Angle of view" (deg) in horizontal direction degrees, not in vertically or diagonally degrees, and also not in (mm) "Lens Focal Length". If you don't know how to convert/calculate from mm to horizontal degrees, look this option: https://www.scantips.com/lights/fieldofview.html#top

In the following three elements of support presented through Figure 4.4, Figure 4.5, and Figure 4.6, in addition to a textual explanation of the correct way of assessing the positive or negative direction of the angular movement to be collected, animations were created to exemplify each situation in video format, in order to pedagogically assist and avoid any doubts or incorrect interpretation. In addition to the illustration, links to those videos will be presented in footnotes.

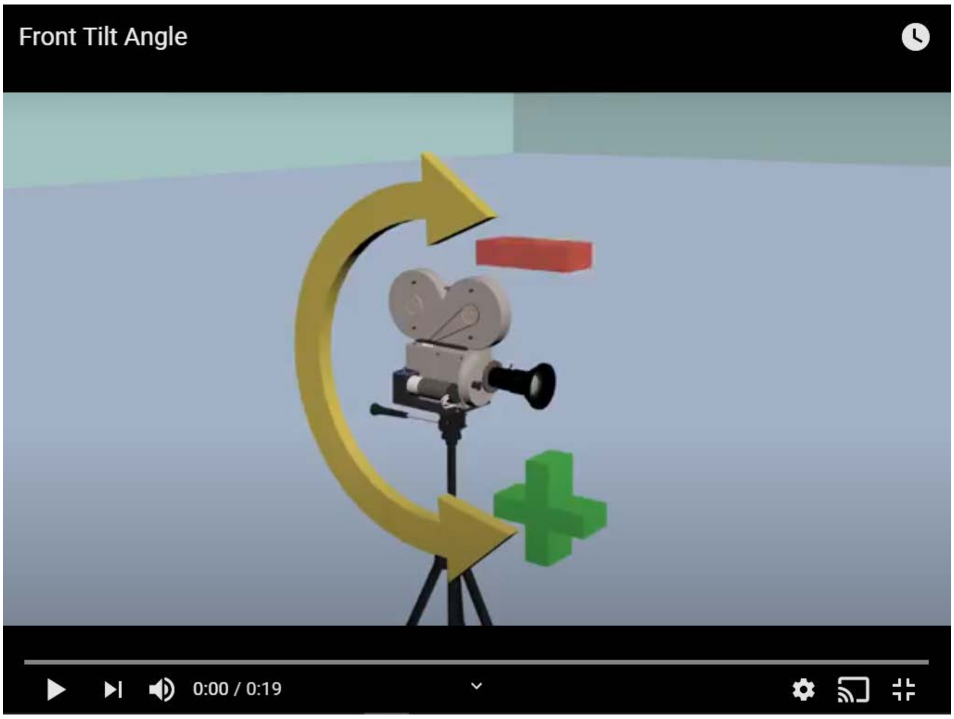


Figure 4.4 - Front Tilt Angle - In degrees (positive up and negative down)[7]

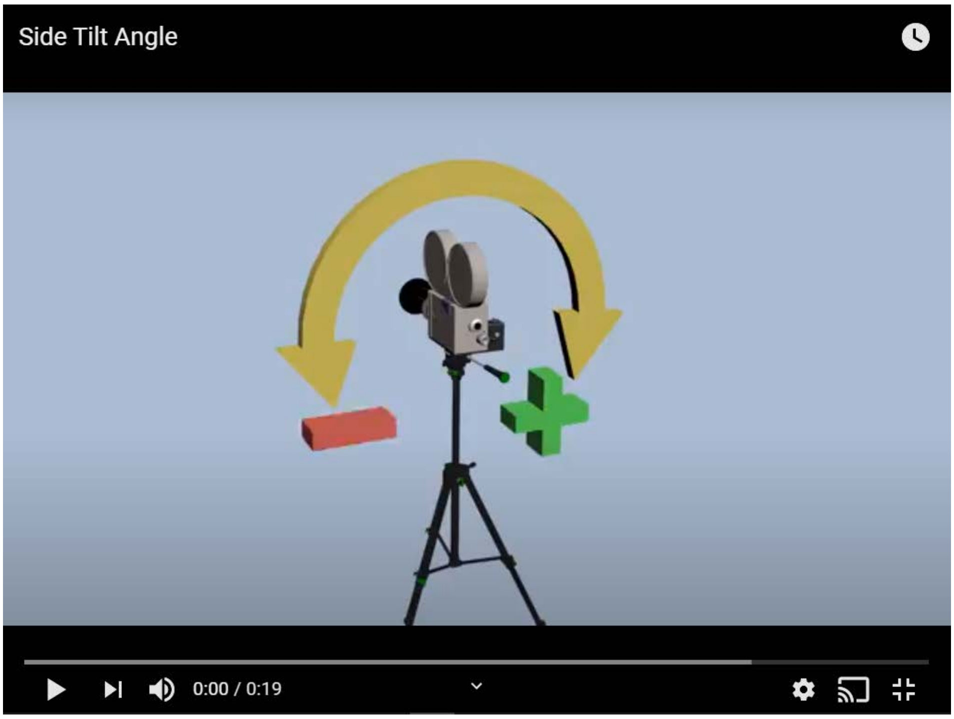


Figure 4.5 - Side Tilt Angle (Dutch Angle) - In degrees (positive to the right {clockwise} and negative to the left {anticlockwise}) (0 degrees - default)[8]

[7] Available at: https://www.youtube.com/watch?v=HQdyp23H_6k
[8] Available at: https://www.youtube.com/watch?v=szoAwlOvLuY

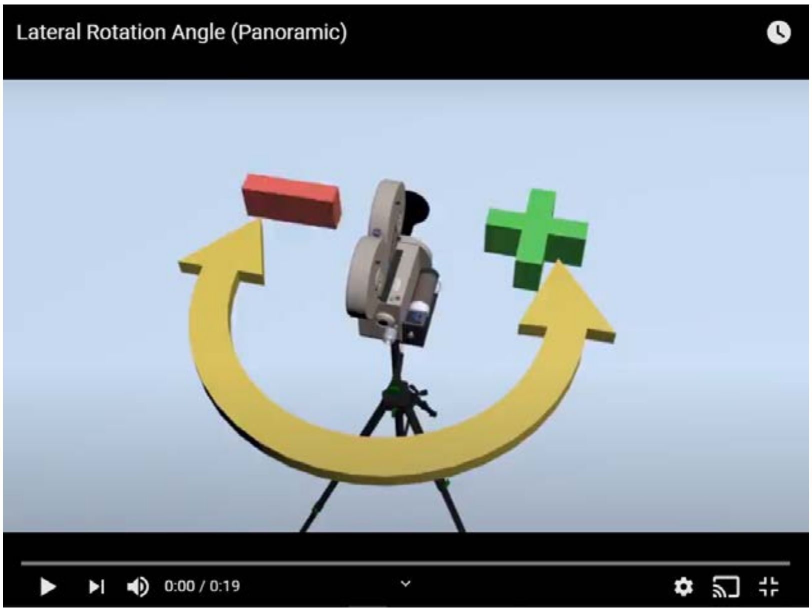


Figure 4.6 - Lateral Rotation Angle (Panoramic) - In degrees (positive to the left and negative to the right). If you are using a target camera, this data will not be used. Put any value only to don't left blank[9]

The next support element (Figure 4.7) presents an illustration to show which is the standard position of creation of a camera in the digital universe for the correct insertion of data of its position (to where it is pointing according to the cardinal points).

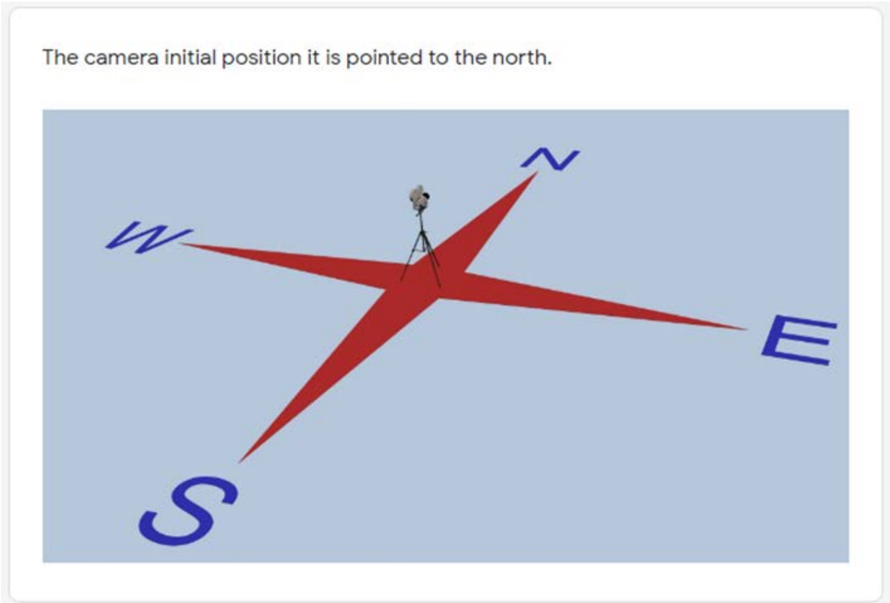


Figure 4.7 - Alert for the Lateral Rotation Angle (Panoramic) - The camera is created by default pointing to the north, this is the reference for the insertion of the values, mainly to Lateral Rotation Angle (Panoramic). For instance, if the camera is in the zero position and it was pointed to the south, the angle to be inputted will be 180 or -180 degrees

[9] Available at: https://www.youtube.com/watch?v=19TB9eMofo4

The next illustration (Figure 4.8) is used for the five elements below. Each one presents a text according to the context in which it is inserted in the tool, however, all seek to make it clear how the user should make the correct reading of the three spatial axes to collect and transpose the data.

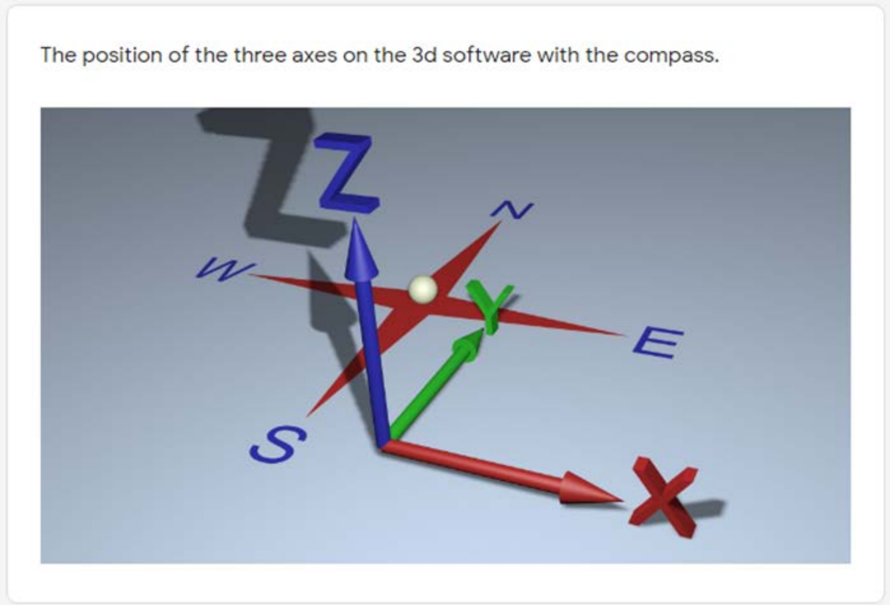


Figure 4.8 - The position of the three axes on the 3d software with the compass - Used on a wide variety of occasions such as for Camera Spatial Position, Spatial Position of Light, Gray Ball Spatial Position, Length and Width of Plane, Spatial Position of the Reference Rod

The next support element explains to the user that in order to obtain the data to be collected (Exposure Value) it is necessary to know 3 camera configuration information. In addition, it also presents two external links where it is possible to make the necessary calculations to obtain the value if it is not known how to do it without this aid.

Exposure Value
To calculate the exposure value you need to know 3 camera setup information: shutter speed, f / stop, and iso (asa). If you need, you can use these two sites suggested below to calculate the "EV":
-> https://www.scantips.com/lights/evchart.html
-> https://rechneronline.de/exposure/

Below, there is a support element that has already been mentioned in the item "Units of measurement". In this context, it is about the provision of external links for the possibility of making conversions between the units of luminosity intensity.

Unit of measure of luminous intensity
There are several types of units of measure of luminosity, the three most used are Lumens, Candela and Lux.
In this tool the unit used is Lumens, so if you are performing the measurement using another unit, you can convert it using, for example, the following suggested sites below.

Lux to lumens -> (https://www.rapidtables.com/calc/light/lux-to-lumen-calculator.html)
Candela to lumens -> (https://www.rapidtables.com/calc/light/candela-to-lumen-calculator.html)

If you do not know what the "apex angle in degrees" to convert directly Candela to Lumens you can convert Candela to Lux and then Lux to Lumens, using only the distance from the light point to the measuring device.
Candela to lux -> (https://www.rapidtables.com/calc/light/candela-to-lux-calculator.html)

If you do not have a device for measuring the luminous intensity you can try to obtain a value by calculating as from the power in watts (knowing the type of light).
Watts to lumens -> (https://www.rapidtables.com/calc/light/watt-to-lumen-calculator.html)

The support element that follows was mentioned in the item (4.5.1) "Technical freedoms and limitations of the project", which deals with the impossibility of transposing natural light data to **CGI** software through **MAXScript**. Below you can see the instructions created in the tool that has to do with capturing numerous data related to natural lighting. A way to alert and teach at the same time.

Natural Light
Lighting systems simulate sunlight based on location and time of day, month, and year. This makes it easier to set up than if you had to simulate sunlight using standard or photorealistic lights.

The Sunlight and Daylight systems use light in a system that follows the geographically correct angle and movement of the sun over the earth at a given location. You can choose the location, date, time, and compass orientation. You can also animate the date and time. In addition, you can animate Latitude, Longitude, North Direction, and Orbital Scale.

Note 01:
There is the possibility of downloading weather data through sites that record the data collected by the meteorological stations around the world. Through this type of file (Weather File) with the EPW extension, it is possible to import the meteorological information of the day of the recording of the scene, with varied data like date, time and place (latitude, longitude, north direction), among others.

Note 02:
The Sunlight and Daylight lighting systems do not allow the insertion of data through Script, for this reason, the data collected must be inserted manually into the 3d animation software. The Script generated although not transporting the data to the system will create a Daylight system and will inform the data (at the end of its execution) for later insertion of the data. The user can also access all data collected through the copy of the completed form that will receive by email at the end of the use of the tool.

The next two supporting elements, in addition to instructing, also have external links to aid in understanding and correct selection of the information to be collected in the respective data fields.

Time Zone
Time zones range from –12 to 12. If you're uncertain about a time zone, you can look them up on this website for example (https://www.timeanddate.com/time/map/).

Diffuse Horizontal Illuminance
The illuminance of the sky measured by a luminance meter placed horizontally, outdoors, excluding the contribution from the sun (10000.0 lx. - default). Note: If you chose American units as the active lighting units, the illuminance values appear as footcandles (fc) rather than lux (lx). This value corresponds to the light intensity for the geographic location of your model. Light intensity increases, the closer you are to the equator, approximately by the values provided in the next illustration (Figure 4.9).

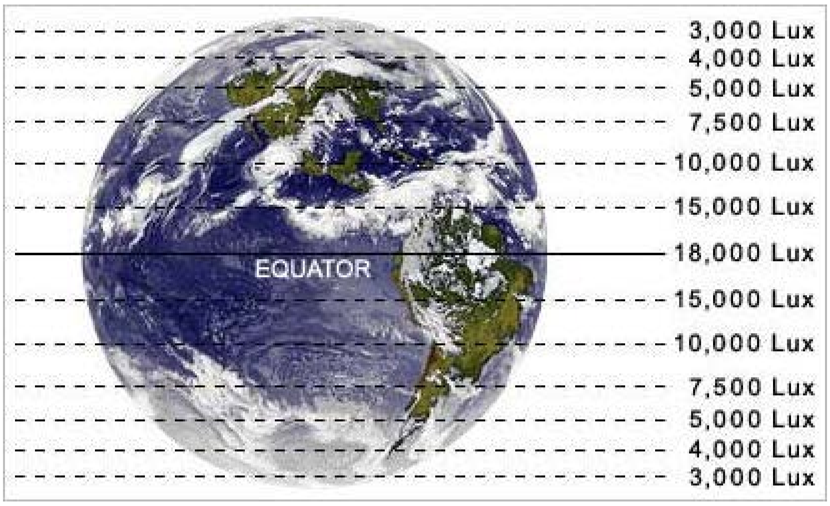


Figure 4.9 - This value corresponds to the light intensity for the geographic location of your model. Light intensity increases, the closer you are to the equator, approximately by the values provided by the illustration[10]

The next is another example of a support element that has an external link to a tool that helps in choosing a color intuitively by presenting the respective RGB codes.

RGB color
The red, green, and blue components of the light's color.

You can use this option if you want to use a color disc to inform approximately the color of the light (unlike the photometric lights that allow you to collect an accurate color data in Kelvin temperature). Following is a website that allows you to get the RGB data from a color disk, there are several with the same functionalities (https://www.rapidtables.com/web/color/color-wheel.html).

This other support element is different than the others because although it is also related to the configuration options of the tool during data collection, it also has the function of assisting by presenting complementary information.

In other words, it has mainly a pedagogical and didactic intention, since the knowledge it comments and presents is relatively more complex to possibly be used at the time of data capture. However, its intention is precisely to arouse curiosity in students and users of the tool, presenting such features and technologies that can be investigated later or at the same time.

Tip for the next step (the type of light distribution)

The Photometric Web File option allows you to later select a file with .ies or .cibse or .ltli extensions.
Web distribution is based on a geometric mesh that models the intensity distribution pattern of a light source.
In general, IES files result in more accurate lighting results in rendered images.
For more information please visit the websites suggested below.

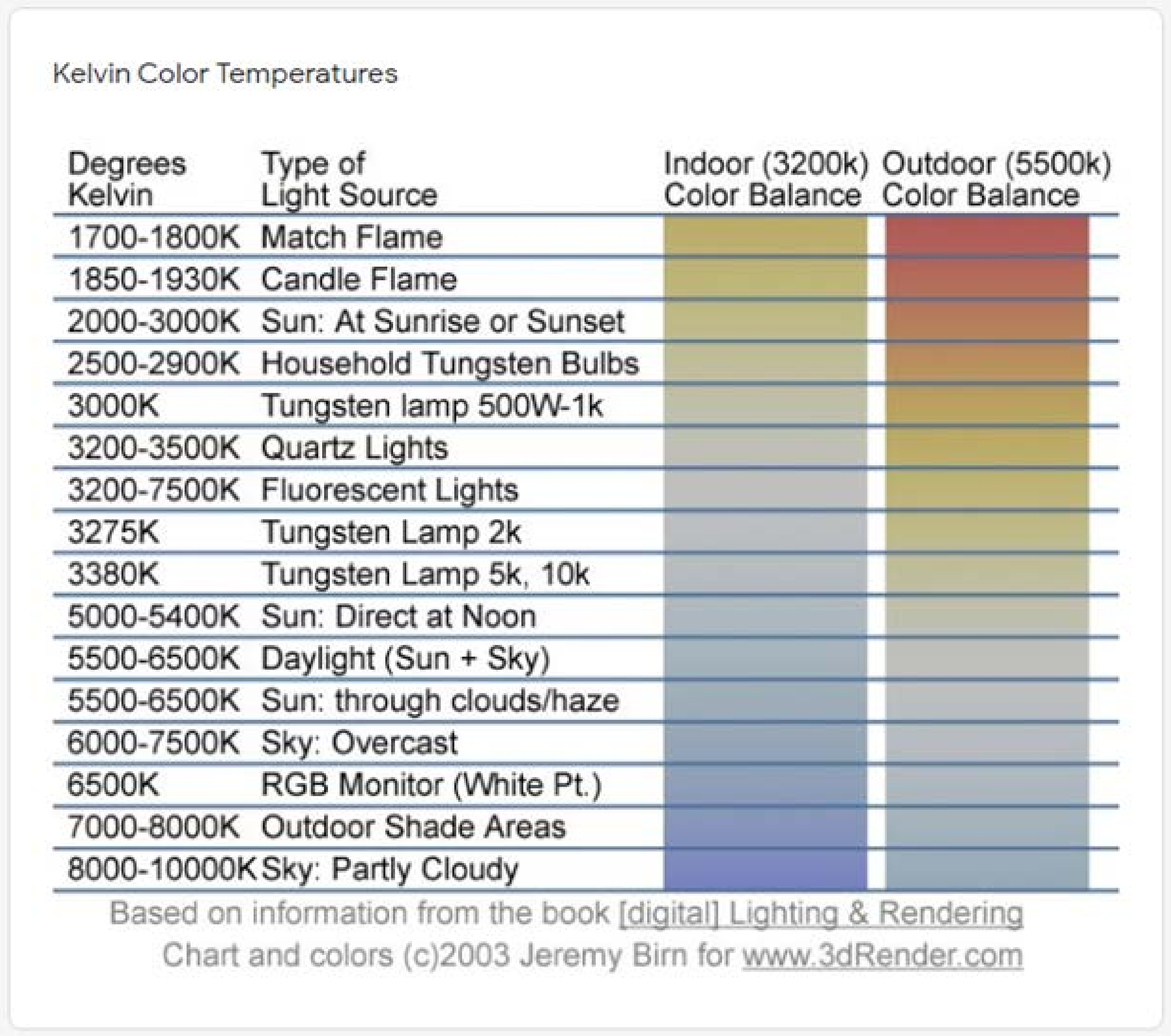
(https://knowledge.autodesk.com/support/3ds-max/learn-explore/caas/CloudHelp/cloudhelp/2019/ENU/3DSMax-Lighting-Shading/files/GUID-8CF2ABB6-41F1-48B4-9BA3-C8E8C47941B6-htm.html)

[10] Graphic subtitle and image from: http://help.autodesk.com/view/3DSMAX/2016/ENU/?guid=GUID-65DD9716-74C7-405F-B05B-9E8C1E2CA306

(https://knowledge.autodesk.com/support/revit-products/learn-explore/caas/CloudHelp/cloudhelp/2015/ENU/Revit-DocumentPresent/files/GUID-21089EF8-4DD4-4DCE-A7F7-C21F7B239E21-htm.html)

This next support element (Figure 4.10) is very important and relevant in the context of VFX production as it presents a color reference table according to the camera's white balance setting used for filming.

The ideal, in this case, would be to use a colorimeter that reads the color temperature of the light on the Kelvin scale (one of the devices presented at the beginning of the use of the prototype if desired). However, in the absence of this type of measuring instrument, tables like the one shown below are of great help for a good combination between the illumination of the virtual scene and the real one.


Kelvin Color Temperatures

Degrees Kelvin	Type of Light Source	Indoor (3200k) Color Balance	Outdoor (5500k) Color Balance
1700-1800K	Match Flame		
1850-1930K	Candle Flame		
2000-3000K	Sun: At Sunrise or Sunset		
2500-2900K	Household Tungsten Bulbs		
3000K	Tungsten lamp 500W-1k		
3200-3500K	Quartz Lights		
3200-7500K	Fluorescent Lights		
3275K	Tungsten Lamp 2k		
3380K	Tungsten Lamp 5k, 10k		
5000-5400K	Sun: Direct at Noon		
5500-6500K	Daylight (Sun + Sky)		
5500-6500K	Sun: through clouds/haze		
6000-7500K	Sky: Overcast		
6500K	RGB Monitor (White Pt.)		
7000-8000K	Outdoor Shade Areas		
8000-10000K	Sky: Partly Cloudy		

Based on information from the book [digital] Lighting & Rendering
Chart and colors (c)2003 Jeremy Birn for www.3dRender.com

Figure 4.10 - Tip for the color temperature of light in Kelvin

There are several other elements of support in the tool, however, to avoid an excess of information in this section it is believed that the others can be located and appreciated through the appendix to this thesis (page 204).

Some of these other elements that can be found are:

- Images with examples of “Reference Balls and ColorChecker”.
- Image to exemplify what would be a plan to receive transparency (alpha channel) in “Data Collection for a Plan”.
- Images of different types of color checkers from different manufacturers.
- Images to illustrate what are "Chroma-Key References for Camera Trackers".
- Images to illustrate the importance of "Creation of photos or film in 360º for (virtual) reflections".
- Warning about the confusion that is sometimes made between Pixel Aspect Ratio (**PAR**), and different types of image aspect ratios as Display Aspect Ratio (abbreviated **DAR**, also known as image aspect ratio and picture aspect ratio), and Storage Aspect Ratio (**SAR**).

4.5.7.Third-party license and trademark use

This section on the license is divided into two parts, the first part dealing with the prototype license, **DLO** developed during this PhD and the second part that comments on the use of the 3ds Max® brand in the tool.

The prototype was licensed under the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International License. It allows others to download and share the work if they assign the credit but cannot change or use it for commercial purposes. In the Figure 4.11 below you can see how the license is presented in the form / **DLO**.

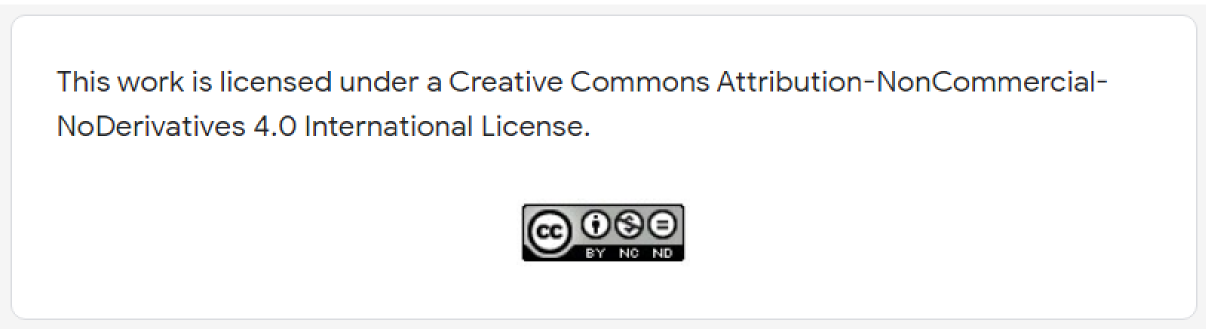


Figure 4.11 - How the licensing chosen for the tool is displayed

Regarding the correct use of the 3ds Max® brand in the tool (software from the Autodesk company), the manufacturer's indication for this type of application was researched. A usage guide was found on a page dedicated only to “Legal Notices & Trademarks”[11].

From the indications found, some variants were elaborated for the possible name of the prototype, and the Figure 4.12 below presents the final name chosen “VFX Tool for 3ds Max®” in addition to the correct legal information as indicated by the owner of the **CGI** software.

---

[11] Available in: https://www.autodesk.com/company/legal-notices-trademarks/trademarks/guidelines-for-use

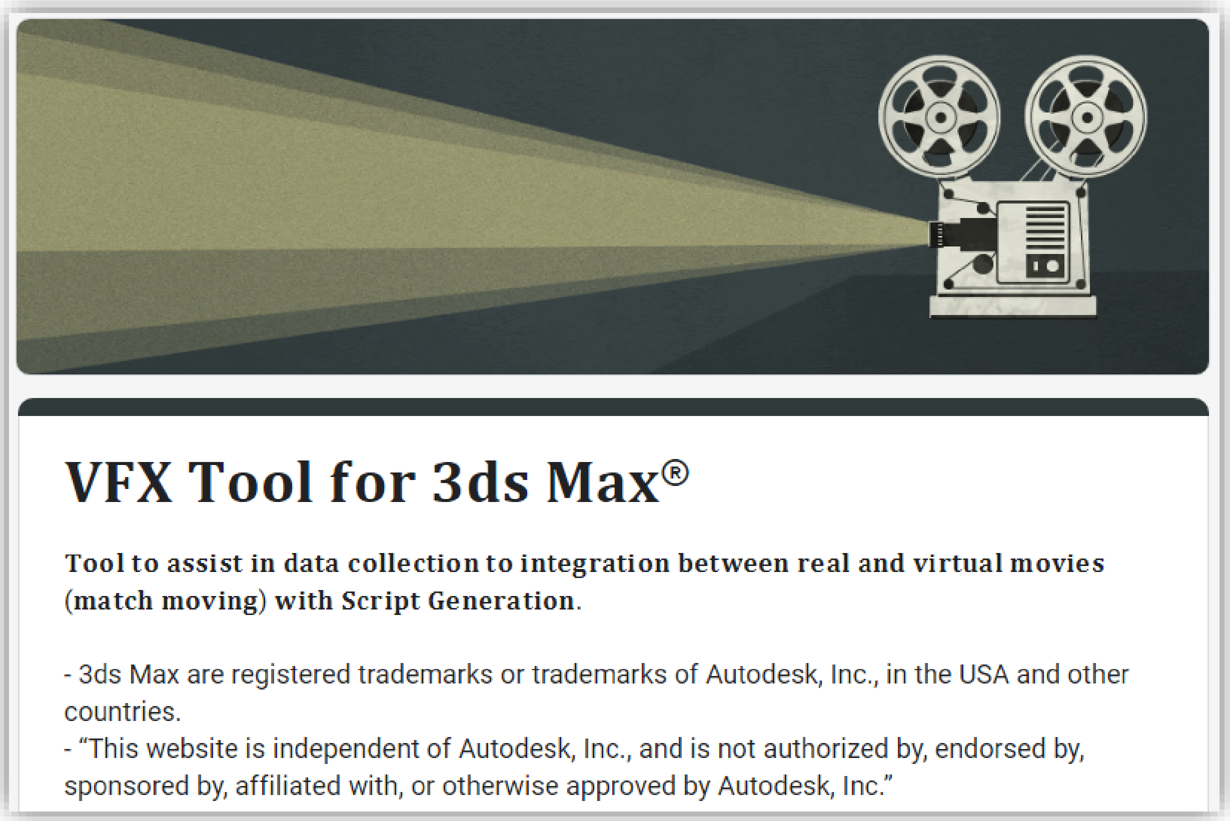


Figure 4.12 **-** The final name adopted for the tool and legal information related to the company that owns the related computer graphics software

In addition to these two legal issues, the researcher was also concerned with embedding a warning, bearing in mind that the tool is based entirely on third-party software, which can change the availability and type of its services at any time and without prior notice.

> **Attention**: Although this tool was developed to support the teaching activity in the audiovisual area, it can be used freely in amateur or professional productions, however, the author is not responsible for any problem, error, damage (direct or indirect), defect, loss of data or system instability during or after its use.

At the end of the use of the tool, more information about it is available in the form of “credits”. Such information can be seen at the end of the appendix (page 204) which presents the entire tool.

4.5.8.Receipt of the filled form and script

After using the tool, the user receives two automatic emails, the first with the entire form filled in, so that he can consult the collected data and, if desired, use it in any **CGI** software to continue the Match Moving task, and a second email with the link to download the script generated for use in 3ds Max® software.

In Figure 4.13 it is possible to see how the script is seen for the first time when it is accessed through the link made available through the second email received, which contains instructions on how to download it correctly and run it using the **CGI** program.

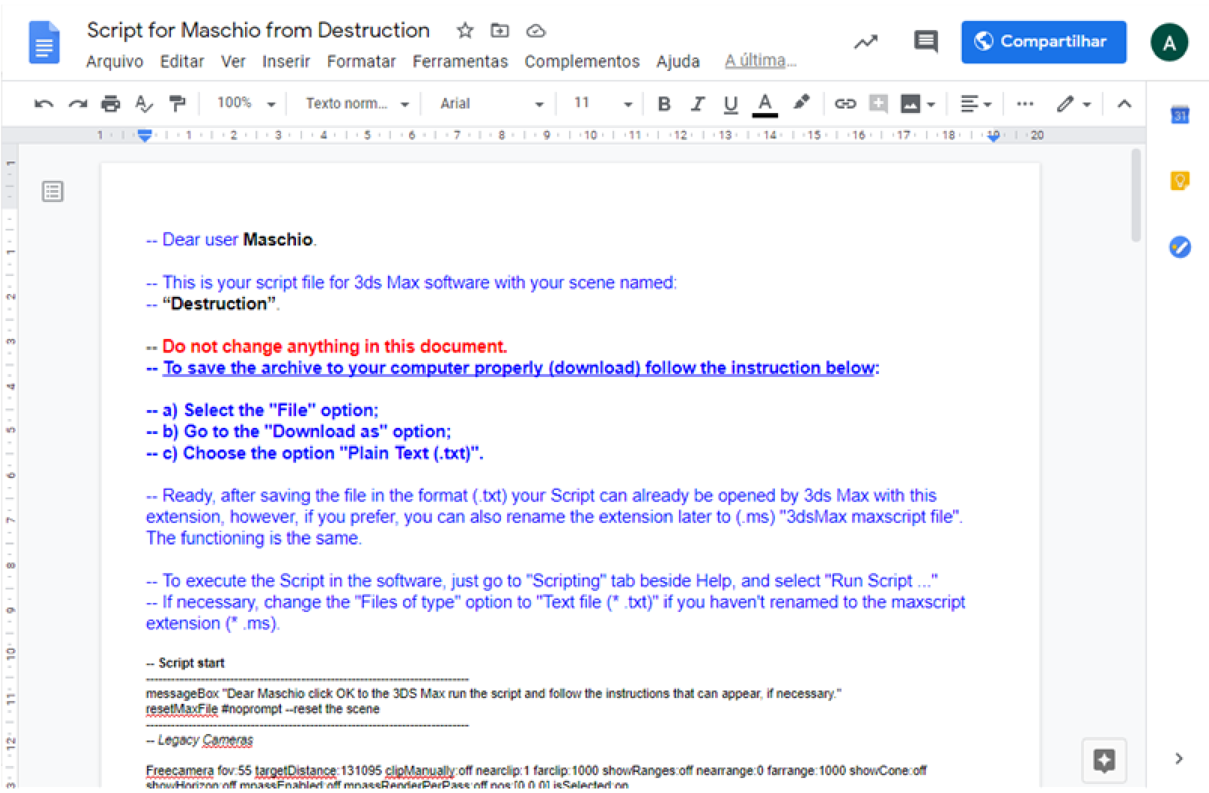


Figure 4.13 - How the script is received by the user with instructions on downloading and how to run it

A complete script is available in the appendices (page 194) for consultation, where it is possible to see the entire **MAXScript** language used by the tool, in addition to being also in the color formatting of the programming language itself, different from the Figure 4.13 above, which has different text formatting, as sent to the user. In other words, the script sent to the user is presented with the color and bold format shown as in Figure 4.13 to reinforce the importance of not changing the content of the document (as it is a programming language, and any undue changes may interfere with the correct execution of the Script). Additionally, it highlights the name of the user, the name of the scene and the download instructions. The script that follows in the same document, presents simple formatting and no color or bold formatting (different from the programing language formatting, presented in the Appendix Script).

4.5.9.Website

To access the website related to this research the following QR Code (Figure 4.14) could be used.

Figure 4.14 - QR Code to access the website related to this Ph.D. research

For the tool to meet some important characteristics to be classified conceptually as a digital learning object as advocated by authors such as Tarouco et al. (2014) and Braga (2015), it was necessary to create a website to house the tool and complement it, with informative items such as its metadata and instructional structure (information about the general and pedagogical goal of the tool, usage guidelines and instructions for teachers and students, and in which study program it can be used).

The importance of also using a website to host the DLO goes accompanies what is portrayed in the work of Medio, Limongelli, Marani, and Taibi (Retrieval of Educational Resources from the Web: A Comparison Between Google and Online Educational Repositories, 2019) wherein this comparison between searching directly through the Google search engine brought more positive results than searching directly in the repositories of educational objects (MERLOT, CNX, and WISC). In other words, even though the repositories strive to find relevant materials and present richer information about DLOs through metadata, there is the relevance of also making these educational resources freely available on the WEB.

In this way, the website was created which, in addition to housing the tool and such instructional and metadata content, also presents complementary information about this doctoral research.

In addition to the website, the tool itself also has an observation right at the beginning, presenting it as a result of this doctoral work and providing the link to the website, as perhaps some user may have had access to the tool directly through the form link.

Thus, regardless of which way the tool was reached (whether through the website, directly through the tool link, through a web search or through digital learning repositories), the user will have access to the instructional components made available through the website.

These are elements that make up the Website:

- In its “**Home Page**” it contains general information about the research, such as the title of the research, the name of the doctoral student, the name of the institutions involved, the name of the supervisor, abstract, in addition to links to the website of the supervisor, student responsible for the research and the pages related to the doctorate in the various institutions that shelter it (for being an interinstitutional doctorate). A large QR Code was also inserted on the home page at the end, so that it could be used by the researcher when presenting at events and congresses, in order to facilitate viewers' access to the respective doctoral page, where they find more detailed information about the project and the tool itself for its use.
- In the “**Research Proposal**” option, it is possible to access the research project approved by **CAT**.

- In the "**UML Diagrams**" option, it is possible to access to the diagrams produced to assist in the development of the prototype.
- In the "**Learning Objects**" option, some concepts about learning objects are available, in addition to metadata that feeds the International Bank of Educational Objects (BIOE) featuring items such as Title, Author, Language, Country, E-mail, Date of publication, Level of education, Curricular component, Type of resource, Theme, Feature description, Objective, Prerequisite of the resource, Keyword, Note, Initial file for execution, Copyright Holder and License. It also provides links to the international repositories in which the **DLO** is available, in addition to presenting the Instructional Structure, through elements such as The technology used for its construction, General Objective, Pedagogical Objective, Instructions for Use, Pedagogical Instructions for Students, and Teaching Instructions for Teachers.
- In the option "**VFX Tool for 3ds Max®**" the link to access the prototype **DLO** is shown.
- In the "**Researcher**" option, it contains information and contacts of the doctoral student proposing this research, as well as a link to the curriculum in the Lattes Platform[12].

4.5.10. The final version of the tool (DLO)

The creation of this item was intended only to end this entire technical execution path and to observe that in addition to the tool being available for use, it was also included as an appendix (page 204) all types of screens available for use in the tool (without redundancy - since it is possible to collect data from more than one unit of certain elements such as cameras and lights). That way is possible to view all available fields for each type of element that may have its data collected and be automatically reconstructed in the **CGI** software by script by the application.

4.5.11. Tests

The tests, as described by Braga "will be carried out by the entire team, including the plaintiff. Among the tests carried out, we highlight usability tests, defect identification tests, portability, and access tests." (Braga, 2015, p. 54).

Braga describes the two main objectives for the execution of tests.

> The tests have two objectives: 1) to show if what the learning object does is exactly what it was proposed for and 2) to discover the defects of LO before its use. The first objective leads to the performance of validation tests, in which the LO is expected to be performed correctly. The second objective leads to defect tests, in which LO errors are identified, in order to find solutions. (Braga, 2015, p. 127)

The main intention in the testing stage is to improve the quality of the LO, for this Braga lists actions to be taken by the development team in order to guide the process, as can be seen below.

> • Compares the idealized context with the existing one, performing tests in different technological realities, with varying numbers of users, on different platforms, etc.
> • Checks whether the generated content is correct and covers everything that was conceived in previous steps.
> • Checks whether the requirements have all been implemented properly and corresponding to the applicant's expectations.
> • Validates the characteristics that define an LO, in particular by analyzing its reusability.
> • Evaluates, in general, the architecture of the LO.

[12] More information about this Brazilian platform for integrating curriculum bases, research groups and institutions in one information system, can be accessed through the following website: http://lattes.cnpq.br/

> • Finds and allows for the correction of defects before the final implementation of the LO. (Braga, 2015, p. 129)

Such procedures were, therefore, performed and a certain number of errors were identified during the process, mainly in the programming for the generation of the Scripts. They were analyzed, corrected, and tested again, thus removing the detected problems.

In addition to the errors, the use of the tool on different platforms (PC and Mobile), different operating systems (Windows, Mac, Android, Linux), its functionality, accessibility, technical reliability, accuracy, portability, interoperability, usability, maintainability, efficiency, availability, and security were tested.

For these tests, the prototype was sent to be used by both team members and students in the audiovisual area (target audience) so that they could use it, reporting suggestions for improvement in addition to inconsistencies and errors.

4.5.12. Learning Object Repositories

Another important feature in the definition and conceptualization of a digital learning object according to several researchers in the area (Prata & Nascimento, 2007), (Galafassi, Gluz, & Galafassi, 2013), (Braga, 2014), (Braga, 2015), (Tarouco, Ávila, Santos, Bez, & Costa, 2014), (Tarouco, Fabre, & Tamusiunas, 2003) is the possibility of sharing in repositories so that they can be accessed and used by other teachers.

> The use of learning objects called for the creation of digital learning object repositories. The creation of national learning object repositories has become a common strategy in all countries. Digital repositories are generally systems providing infrastructure for storing, managing, retrieving and delivering digital resources. (Saltidou & Skoumios, 2018, p. 435).

Braga points out that “There is no point in having an LO of excellent quality if it cannot be reused because it has not been made available in an easily accessible place.” (Braga, 2015, p. 139):

> • Difficulties in finding LO: teachers and students may not know that a particular LO exists, because the search engines (eg, Google) cannot find it. This problem can cause rework, a situation in which teachers because they do not know that there is an LO that meets their needs, can spend time and money developing an LO that already exists.
> • Difficulties in researching and locating LOs: teachers and students may have difficulties in searching for the LO they want, as it was often not stored with other pedagogical information (eg metadata) such as discipline associated with LO, target audience, etc.
> • Difficulties in preserving LO copyrights: an LO can often be found in a location that does not make clear its moral and property rights.
> • Difficulties in finding good quality LOs: many objects, as they are stored in unsuitable locations, have not undergone evaluation and, because of this, have low quality.
> (Braga, 2015, p. 140).

Braga also argues that “The Learning Object Repositories are, without a doubt, the most adequate databases to organize, classify and store LO, enabling their reuse for their users (students, teachers, and tutors).” (Braga, 2015, p. 140).

For this purpose, preliminary research was carried out about what the most well-known **DLO** repositories at national (Brazil) and international levels. Next, a listing of some of these with their respective **URL**s is presented:

National repositories (Brazil):

BIOE - Banco Internacional e Objetos Educacionais (MEC and MCTI) http://objetoseducacionais.mec.gov.br/
Plataforma MEC de Recursos Educacionais Digitais (MEC) https://plataformaintegrada.mec.gov.br/
RIVED – Rede Interativa Virtual de Educação - Secretaria de Educação a Distância (MEC) http://www.dmm.im.ufrj.br/projeto/rived/index.html
Portal do Professor (MEC and MCTI) http://portaldoprofessor.mec.gov.br/
eduCAPES (CAPES and MEC) https://educapes.capes.gov.br/
Escola Digital - Instituto Inspirare, Instituto Natura, Instituto Educadigital, TIC Educa, Secretaria de Educação do Estado de São Paulo https://escoladigital.org.br/
LABVIRT - Laboratório Virtual da USP (exclusivo para as áreas de Química e Física) http://www.labvirt.fe.usp.br/
Domínio Público http://www.dominiopublico.gov.br/
CESTA – Coletânea de Entidades de Suporte ao Uso da Tecnologia na Aprendizagem http://www.cinted.ufrgs.br/CESTA/cestadescr.html
NUTED – Núcleo de Tecnologia Digital Aplicada à Educação http://www.nuted.edu.ufrgs.br/
Laboratório Virtual de Matemática da UNIJUÍ http://www.projetos.unijui.edu.br/matematica/fabrica_virtual/
Acervo de Recursos Educacionais em Saúde (ARES) - Universidade Aberta do Sistema Único de Saúde (UNA-SUS) https://ares.unasus.gov.br/acervo/
Soplaar - Sistema criado como ferramenta de validação da Tese de Doutorado do professor Cláudio Joaquim dos Santos Braga http://www.soplaar.com/index.php?idioma=1
Curriculo+ - Secretaria de Educação do Estado de São Paulo http://curriculomais.educacao.sp.gov.br/
Currículo Digital da Cidade de São Paulo https://curriculo.sme.prefeitura.sp.gov.br/
Educopédia - Prefeitura da Cidade do Rio de Janeiro http://www.educopedia.com.br/
REA Dante - Recursos Educacionais Abertos do Colégio Dante Alighieri http://www.colegiodante.com.br/rea/
Planeta Biologia http://planetabiologia.com/
Plataforma Anísio Teixeira - Secretaria da Educação do Estado da Bahia http://pat.educacao.ba.gov.br/
Edukatu - Rede de Aprendizagem para o Consumo Consciente http://edukatu.org.br/
REAMAT - Recursos Educacionais Abertos de Matemática – UFRGS https://www.ufrgs.br/reamat/
Recursos educacionais multimídia para a matemática do ensino médio

https://m3.ime.unicamp.br/
Fundação Getúlio Vargas - OpenCourseWare Consortium http://www5.fgv.br/fgvonline/Cursos/Gratuitos/
Repositório SaberCom da Universidade Federal do Rio Grande (FURG) http://www.sabercom.furg.br/

International repositories:

MERLOT (California State University) https://www.merlot.org/merlot/index.htm
OER Commos – Open Educational Resources https://www.oercommons.org/
MIT OpenCourseWare (Massachusetts Institute of Tecnology) https://ocw.mit.edu/index.htm
PhET Interactive Simulations (University of Colorado Boulder) https://phet.colorado.edu/
Stanford ONLINE https://online.stanford.edu/
Science Netlinks http://sciencenetlinks.com/
Wisc Online - Wisconsin Technical College System https://www.wisc-online.com/
BBC Learning English https://www.bbc.co.uk/learningenglish/
CAREO - Campus Alberta Repository of Educational Objects http://www.careo.org/documents/overview.html
Casa das Ciências – Fundação Calouste Gulberkian / EDULOG - Fundação Belmiro de Azevedo (Portugal) http://www.casadasciencias.org/
ARIADNE – European Commission (Oslo) https://www.ariadne-eu.org/

In this way, in order to contemplate this conceptual and relevant element for the distribution and dissemination of the tool, after having passed several tests and finalizing its first version, it was submitted to appreciation in two international **DLO** repositories, Merlot Repository (Brinthaupt, Pilati, & King, 2008, pp. 240-245) and Open Educational Resources Commons (Institute for the Study of Knowledge Management in Education - ISKME - supported by the William and Flora Hewlett Foundation, 2007).

After the evaluation of the tool by these repositories and approval and release for publication, it has been made available for access and is already cataloged in the respective search services and available for viewing, access, and sharing. Braga comments “Peer review of Merlot objects is an activity used to assess the quality of aggregated objects.” (Braga, 2015, p. 151).

The annexes on pages 173 and 174, show the screen of the **DLO** website in the respective hosted international repositories. Below is the respective link for access.

- MERLOT
  https://www.merlot.org/merlot/viewMaterial.htm?id=1379566
- OER Commons – Open Educational Resources

https://www.oercommons.org/courses/teaching-visual-effects-for-audiovisual-production-using-digital-learning-objects

This submission of the DLO to these repositories also sought to meet the best possible need for the correct submission of the necessary metadata for cataloging, in addition to also making the metadata available on the tool website.

The importance of a correct filling and defining the metadata used to supply the repositories of digital learning objects are discussed in detail, within the scope of the “human metadata generation” field, by the work of Currier, Barton, O'Beirne, and Ryan (Quality assurance for digital learning object repositories: issues for the metadata creation process, 2004) which examines a growing body of evidence in addition to three UK case studies to address the issues surrounding human-generated metadata creation and identifies questions for further research on the topic.

Braga also reinforces the importance of metadata in the following quote.

> In the absence of metadata, a repository can limit itself to storing an LO, without providing teachers and students with the possibility of obtaining other relevant information, such as technical and pedagogical information that can facilitate the reuse of that LO.
> In addition to allowing the storage of information about LOs, metadata can facilitate the search, acquisition, evaluation, and use of Learning Objects by learners and instructors or automatic software processes. (Braga, 2015, p. 144).

The procedures adopted, therefore, sought to meet these recommendations so that the DLO can be located and used in a wide and unrestricted way.

Chapter 5 - FIELD RESEARCH

This chapter presents the field research subdivided through topics such as the available infrastructure, the problems encountered and solutions adopted, the necessary authorizations and formalities, the preliminary consultation carried out and its implications, the description of how the mini-course took place, as the research forms were applied, the procedures in the organization of the material produced during the mini-course for blind evaluation, and finally the parallel research carried out with professors in the area.

5.1. Available infrastructure

This section will briefly present the infrastructure that was used under the responsibility of the Department of Digital Media (**DEMID**) of the Federal University of Paraíba (**UFPB**). DEMID belongs to the Center for Human Sciences, Letters, and Arts (**CCHLA**) at **UFPB**. The Bachelor's Degree in Communication in Digital Media (**CCMD**) is linked to the Department and was created by Resolution nº 38/2009 of the Teaching, Research, and Extension Council (**CONSEPE**/**UFPB**).

The two-story building has an auditorium, classrooms with data show and sound system, two laboratories with Apple computers, a laboratory with Windows computers, an audio recording studio, a video recording studio, a video editing laboratory with two specific Apple computers for editing more robust content (4K), collective kitchen, space for the coordination of the course and head of the department, a space to the coordination of the graduate program in communication, among other internal and external spaces for welcoming students when they are not in class.

Some of these spaces will be displayed in the body of the work when discussing how the mini-course/research took place in the section 5.5. Mini-course (page 110).

For the empirical research itself, the following physical spaces were requested:

- Computer lab with Windows.
- Audio recording studio, with all the infrastructure already in place, in addition to the support of the audio technician.
- Video recording studio, with all the infrastructure already in place, in addition to the support of the video technician.

The recording studios already have numerous audio and video capture equipment, lighting systems, editing, and manipulation of recorded content, and acoustically appropriate and air-conditioned environment, among other provisions. The video recording studio, for example, has 9 light channels connected to the light table (dimmer), 1000 W, and 650 W Fresnels, in addition to teleprompters, flat-screen TV, data show, chairs, tables, chroma-key, among others. Forward, the images in Figure 5.1 and Figure 5.2 illustrate what the video studio is like.

Figure 5.1 - Video recording studio of the Department of Digital Media of the Federal University of Paraíba

Figure 5.2 - Video recording studio of the Department of Digital Media of the Federal University of Paraíba

Regarding the technical part, the equipment that was requested to be reserved for use during the practical recording part for the mini-course is listed in the Table 5.1 next.

Table 5.1 - The list with the brands/models and quantity of equipment requested to be reserved for use during the practical recording part for activities of the mini-course

Amount	Description
02	Panasonic AG-HMC80P camcorders
03	DSLR Nikon D5000 each with 18-55 mm lens; CROP 1.52
01	lenses kit with 01 24 mm lens, 01 60 mm lens, 01 105 mm lens, 01 70-300 mm lens
05	Manfroto tripods for camcorder / DSLR
01	led kits (panel, tripod and power supply), each kit with 02 panels
02	Zoom H4n, audio recorder
02	Rode shotgun microphones, 01 NTG-3 and 01 NTG-3B
02	Sennheiser wireless lavalier microphones
02	Minolta Color Meter III F meters

In addition to this equipment that was provided by the university, the coordinating professor of this research also acquired other equipment necessary for the teaching of the mini-course, such as:

- Reference spheres for visual effects, two 18% gray and two mirrored, two sizes each plus the supports.
- Laser measuring tape with a range of up to 40 meters.
- Reference cards 3 in 1, containing 18% gray, white and black.
- 360º rotating laser level.
- Several ColorCheckers (ColorChecker Classic, 18 Gray Balance, Focus, Grayscale).
- Identification badge for use during the course with personal data and QR Code to Ph.D. research home page.

The computers used in the laboratory all had the same hardware and software configuration detailed forward and there were 20 machines available for use.

Hardware[13]:
Brand Name: HP
Series: Z210 Workstation
Item model number: Z210
Hardware Platform: PC
Operating System: Windows 10 Professional
Item Weight: 25.8 pounds
Product Dimensions: 17.9 x 7 x 17.6 inches
Item Dimensions L x W x H: 17.9 x 7 x 17.6 inches
Processor Brand: Intel
Processor Count: 1
Processor Model: Intel Xeon E3-1240 3.3GHz Quad Core CPU
Computer Memory Type: Ddr3_sdram
Memory: 16GB DDR3
Hard Drive: 2x 500GB HD in Raid Striping (performance setting)
Graphics Coprocessor: NVIDIA Quadro 600
Chipset Brand: NVIDIA
Card Description: Dedicated

Software:

- Windows 10 Professional
- Adobe Photoshop CC
- Adobe Premiere CC
- Adobe After Effects CC

[13] Mais informações sobre a Workstation disponível no Guia do Usuário no endereço: http://h10032.www1.hp.com/ctg/Manual/c02785922

- Adobe Media Encoder CC
- Adobe Audition CC
- Adobe SpeedGrade CC
- Adobe Lightroom
- DaVinci Resolve
- 3ds Max 2016
- QuickTime 7.7.9 para Windows
- Suite Microsoft Office

After this presentation of the infrastructure used for the field research, the next section will address the problems encountered during the execution of the activities.

5.2. Problems found

Before the beginning of the field research, it was necessary to think and try to predict what possible problems might occur during the empirical part of the research so that it was possible to foresee such difficulties or simply to warn participants in advance of these difficulties or obstacles that they might have had to face and overcome.

For this purpose, some problems were raised and needed to be included in the Informed Consent Form (**ICF**) produced for submission to the ethics committee and subsequently signed by the participants, as described in item 3.2.3. Below is an excerpt from that document that presents the minimum risks to participants.

> We inform you that this research does not offer predictable risks to your health. However, while participating in the mini-course, ***the sample participants will be subject to minimal risks, such as the possibility of exposure of their identity; from getting hurt while filming to perform the practical exercises (with the fall of some equipment, the fall of the individual if using a ladder, receiving an electric shock when handling electronic equipment; compromising eye health due to direct and rapid exposure to a point of very strong light emission, suffer some inconvenient discomfort due to the facilities of the place where the activities will be carried out (as a defect in the air conditioning system)***.

One of the items scored was the forecast that the computer laboratory where the mini-course would be developed did not have a functional HVAC system because the research proponent already knew in advance that the HVAC equipment had been inoperative some time ago, and without prevision for repair or replacement.

Having knowledge of the situation, efforts were made with the head of the Department of Digital Media (**DEMID**) at the time, in an attempt to corroborate in what was possible to repair or replace the equipment, however, until the date scheduled for the execution of the activities there was no success due to numerous bureaucratic and budgetary factors that unfortunately affect Brazilian public universities in general (as already presented in section 2.1.4).

Without the air conditioning equipment, the computer lab with all the machines on and people in the environment became excessively hot, making the mini-course a real challenge for everyone. Some students sometimes asked to leave the classroom to cool down a little outside the building, others suffered pressure drops, some even took air fans to make the ambient more bearable.

One of the strategies adopted to overcome the heat problem was to realize the entire course and research at night, however, even without the sun, the walls of the laboratory (building) had already been heated throughout the day, which did not solve much of the problem, considering that buildings in Brazil are not usually built with thermal and acoustic insulation.

Finally, it is believed that this may have been one of the biggest problems faced and can be the biggest factor that influenced student dropouts during the activities of the mini-course.

5.3. Necessary authorizations and formalities

The authorizations and formalities necessary for carrying out the field research at **UFPB** were briefly raised through the necessary documentation during the submission of the research to the **REC** e **NREC** ethics and committees covered in item 3.2.3. However, it is important to note that in addition to the formal document for the authorization of the use of spaces and equipment by **DEMID**, several other procedures were necessary together to the technical staff, such as:

- List of software and request to the laboratory intern to install them on all machines and prepare them to be in the same state of hardware and software for the performance of activities.
- Scheduling the use of the computer lab during the entire course (5 days a week for 4 consecutive weeks).
- Scheduling the audio recording studio for the same period.
- Scheduling the video recording studio for the same period.
- Authorization for recording in the computer laboratory itself.
- Discrimination and reservation of all image and audio capture equipment, lighting, stabilizers, etc.
- Scheduling on how and when to close activities every day in view of the mini-course schedule and the needs of the employee responsible for closing the building.
- Authorization for the lab computers spends all night on making the renderings, being turned off in the morning or early afternoon by the laboratory intern or research coordinating professor, before their use in class in the afternoon (time in the Digital Media Communication course).

In the end, all formalities were attended to and the project successfully executed, meeting all the necessary methodological specifications. Thanks are due for the effort of all **UFPB** employees and students involved in the implementation of this empirical phase.

5.4. Preliminary consultation of interest in participation in mini-course/research

The preliminary consultation carried out before the offer of the mini-course/research was carried out to make a closer survey of the real interest of students in the audiovisual area, the target audience of this research.

In advance, there was already knowledge of the existence of 3 undergraduate courses at **UFPB** related to the area of audiovisual production, the number of annual places available, making it possible to have a rough idea of the number of possible students enrolled in the current classes, disregarding the dropout rate in the respective courses.

Taking as a parameter the total annual entries and the fact that all courses last 4 years (8 semesters), an estimate of the total number of students is reached. In addition to this estimate, it was also collected from the university website, a count of the number of active students in the respective courses. Such data is visible in Table 5.2 below.

Table 5.2 - Number of students per course at UFPB

Course	Annual entry	Number of classes	Approximate total students	Active students[14]
Communication in Digital Media	50	4	200	210
Broadcasting (Radio and Television)	40	4	160	176
Cinema and Audiovisual	15	4	60	55
Total	**105**	**12**	**420**	**441**

Despite a relatively large number of students, there was already an anticipated awareness that the theme of producing visual effects would not necessarily be of interest to the majority and in addition to the question of interest in the subject (and in the mini-course to be offered), there were others known elements that could influence the demonstration of interest, availability, and commitment to the course:

- Course offered at night - which adds several implications such as the issue of security to get from the university to home at the end of the night, considering that in the city of João Pessoa the crime rate is still high and unfortunately there are robberies both in public transport buses and in transit on foot on and off the university campus.
- Physical and mental wear and tear on the students, given that many do internships at alternate times than their respective undergraduate courses (usually in the morning when the course is in the afternoon), but also a reason for choosing the evening period.
- Problem already mentioned regarding the lack of air conditioning in the laboratory where the activities related to this research were conducted.

Thus, it was imagined at first, that even with such obstacles, due to the approximate number of 420 students in total, it would still be possible to form two classes with a minimum of 30 and a maximum of 40 students each, to work with separation of the variable to be researched using a simpler research methodology, only Inter-subjects. In this case, we would be working with the possibility of a total of 60 to 80 students, which would correspond to 14% to 19% of the total.

However, because considering the difficulty of relying on third parties to carry out empirical research, it was decided to elaborate the preliminary consultation that will be described shortly, so that it was possible to measure the real interest of this universe of students that we would like to reach.

This digital form was produced in Portuguese, considering that it would be the first contact with the possible interested parties, and it would also serve to measure the qualification of those interested in the English language. Furthermore, it is available in its entirety as an appendix on page 199, therefore, only three excerpts extracted from it (in English) will be displayed in the body of the thesis, considered the most relevant in relation to what is being presented.

In this preliminary consultation, the following items were used in the referred digital form.

[14] Quantidade de alunos ativos informada diretamente através do site da instituição abaixo:
Comunicação em Media Digitais: https://sigaa.ufpb.br/sigaa/public/curso/alunos.jsf?lc=pt_BR&id=1626827
Radialismo: https://sigaa.ufpb.br/sigaa/public/curso/alunos.jsf?lc=pt_BR&id=1626774
Cinema e Audiovisual: https://sigaa.ufpb.br/sigaa/public/curso/alunos.jsf?lc=pt_BR&id=1626772

Personal data

With e-mail collection of the interested party and full name.

Description of the short course/research

Featuring elements such as Title, Proposition, Objective, Prerequisites, Certification, and Keywords.

Notifications

Four notices were made, the first informed about what this pre-registration/consultation was about, the second warning explaining the reason for this pre-registration/consultation, the third warning with an alert explaining that the consultation was not a guarantee of vacancy later when the short course had was effectively offered, and the fourth and last one presenting the contacts of both the responsible researcher and the Ethics Committee responsible for the project (something mandatory according to the **REC** and **NREC** for all documents created to contact the respondents).

To assist in the dissemination of this formulary of consultation of interest, art was created which was used in print for the dissemination in the murals at the university (appendix **VI**), as well as the dissemination on social networks.

Results, analysis, and taken actions

Starting from the universe of 420 students, the consultation obtained 65 responses during the 6-week period in which the form was open to receive expressions of interest. The number of students who expressed a possible interest in the mini-course, therefore, corresponds to approximately 15% of the total target audience.

However, knowing that some of them might not be able to participate due to various external factors, which could lead to difficulties in obtaining a total of 60 students (two classes of 30) or in the worst case, 40 students (two classes of 20), it was important to anticipate a possible problem of not obtaining the number of participants that were previously foreseen for a simple methodological design of only inter-subject.

With this concern in mind, a study was carried out with the invaluable support of the team member, the Doctor in Experimental Psychology Ph.D. Ricardo Gaspar Viegas (from Lisbon, Portugal) on a methodological alternative in the case of a reduced number of participants (15 to 20 in total). In this way, a new methodological design was developed using inter-subject and intra-subject techniques, in order to take advantage of the statistical power of repeated measures. The new design, although more complex, would also guarantee greater elegance in the analysis. The new methodology was also submitted to the research ethics committees to change the initial project through an amendment to the project that later was approved.

In summary, this preliminary consultation provided support for it to be possible to think of an alternative methodological plan for field research in advance so that even with fewer participants, it would still be possible to infer statistically valid data.

The most relevant results collected by this preliminary research will be presented forward.

Regarding the question about what year the student was enrolled, the measured result can be seen in the graph (Figure 5.3) that follows below, where it is possible to notice a relatively close interest among second, third and fourth-year students (with slight decay between them, in that order) and lower participation of first-year and graduates.

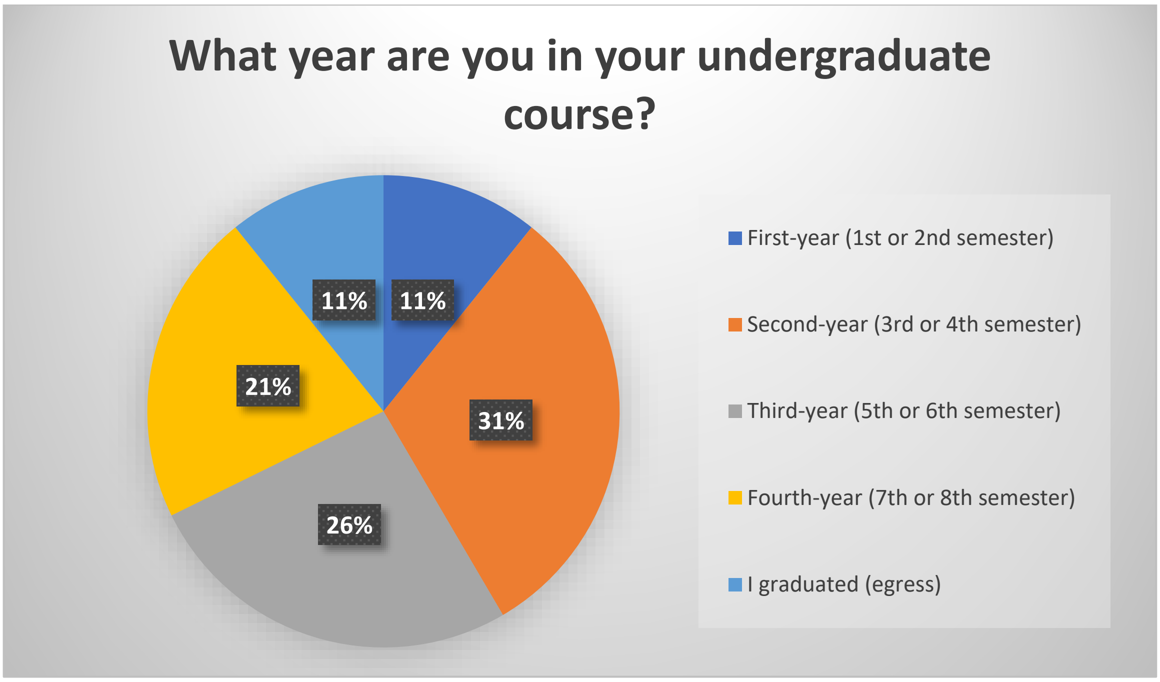


Figure 5.3 - Year the student is enrolled in the undergraduate course, or if he is an egress

Regarding the question about what situation best described the student's situation, we can see in the next graph (Figure 5.4) that a large majority (56.9%) described themselves as a student regularly enrolled in the Digital Media Communication course at **UFPB**; 12, 3% described themselves as a student regularly enrolled in the **UFPB** Cinema and Audiovisual course; 13.8% described themselves as a student regularly enrolled in the **UFPB** Broadcasting course; 9.2% (6 respondents) as a student in the audiovisual area (undergraduate level) from another institution (public or private); and the remaining 7.5% (5 respondents) are distributed among the other possible answers.

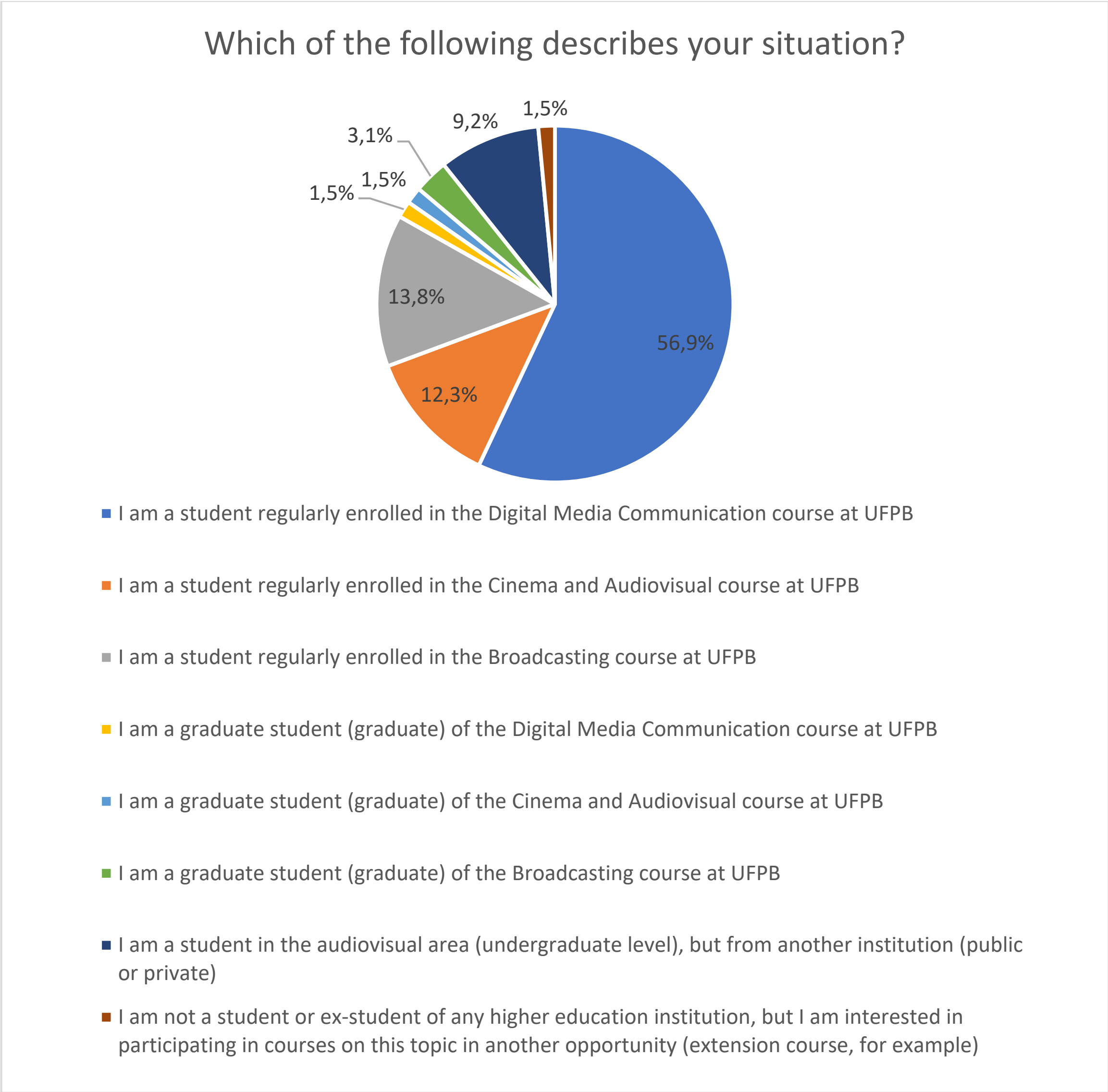


Figure 5.4 - Which situation best describes the student's situation

This questionnaire was interesting because it showed a prevalence of students of the Digital Media Communication course in relation to the others, however maybe this happened because it was possible to better reach this group of students through the groups on social networks where it was possible to disseminate the mini-course / research because one of these groups was exclusive of students of this course, on the other hand, the Cinema and Audiovisual and Broadcasting courses did not have specific groups of students for the dissemination of the course, and the groups closest to this audience were closed, not be possible to publish in them.

The next graph (Figure 5.5) deals with the availability to participate in the mini-course/research according to the three possibilities presented. This question was intended to assess in which shift there would be more students with availability to participate, and if there would be greater availability if the course was offered during the week or on weekends.

Of the responses collected, 78.1% (50 participants) showed availability to participate in the course if it was offered in the evening, during the weekdays. Another 32.8% (21 participants) demonstrated availability if the course was offered in the morning and evening shifts, during the weekdays. Finally, 29.7% (19 participants) demonstrated availability to participate in the course if it was offered in the morning and afternoon shifts on weekends.

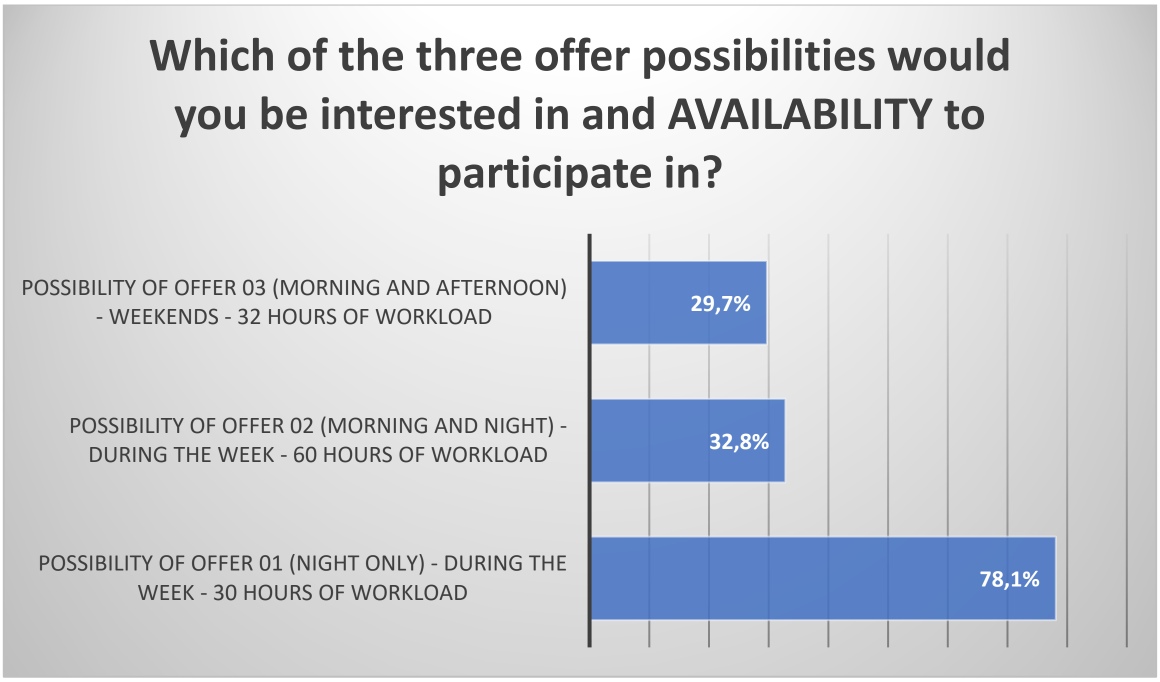


Figure 5.5 - Availability among three possibilities, being able to choose more than one option or all

The next graph (Figure 5.6) shows the preference of these 64 respondents, and in this question, they were only able to choose between one of the three offer options. It can be seen that the vast majority of respondents 65.6% (42 respondents) indicated that they prefer to take the course at night only.

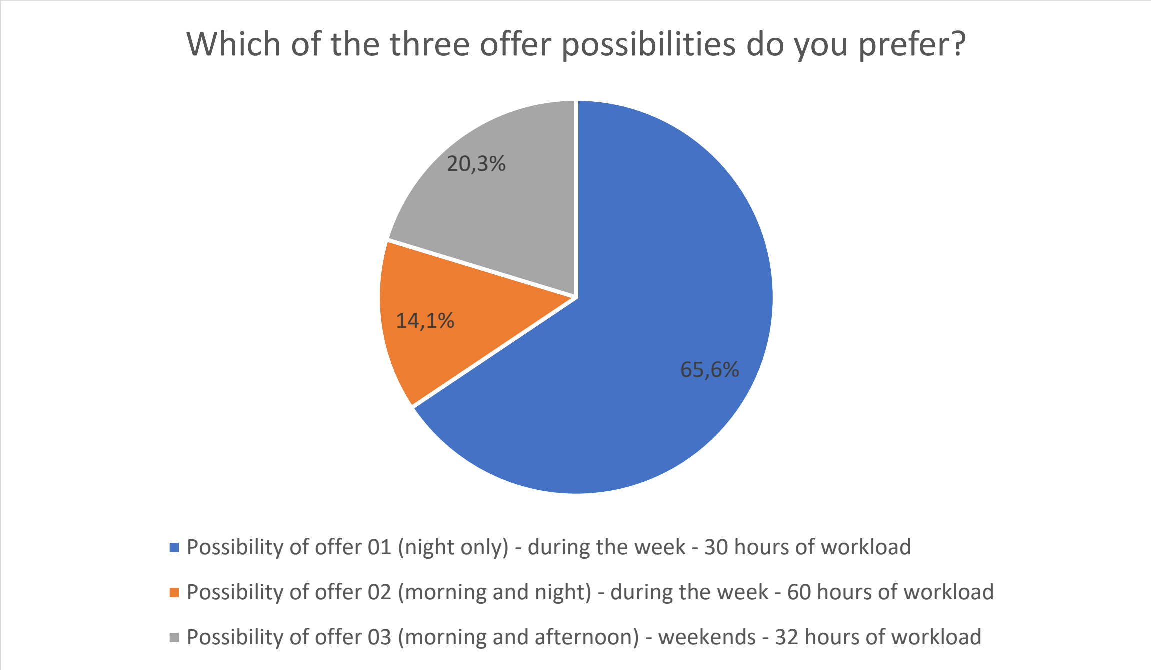


Figure 5.6 - Preference among three possibilities, where only one option could be chosen

The crossing of data from these last two graphs is relevant because it is possible to extract a greater manifestation of availability 78.1% (50 out of 64) when offering a course only at night and with regard to preference 65.6% (42 out of 64) for the same option.

When evaluating only the preference bias, the actual number of people would be reduced to 42 possible participants, without taking into account the real difference between an expression of interest and preference and the real effectiveness and commitment to participation in that course.

For this reason, it is possible to envision in advance the future difficulty of obtaining two classes of 30 or even 20 students. For this reason, we could emphasize the importance of this preliminary research to anticipate fewer participants by carrying out the previously mentioned methodological redesign in due time.

Finally, the next graph (Figure 5.7) related to this data collection presents the previous knowledge declared by the participants to contribute to a better preparation of the content and pedagogical strategies to be used in the mini-course. On the form, it was possible to mark all the alternatives available.

Analyzing the results, it is possible to confirm the indication that a relative majority of undergraduate students who participated 84.4% (54 of the 64 respondents) have knowledge in English, which leads to confirmation of the correct decision choosing English for adoption in the prototype.

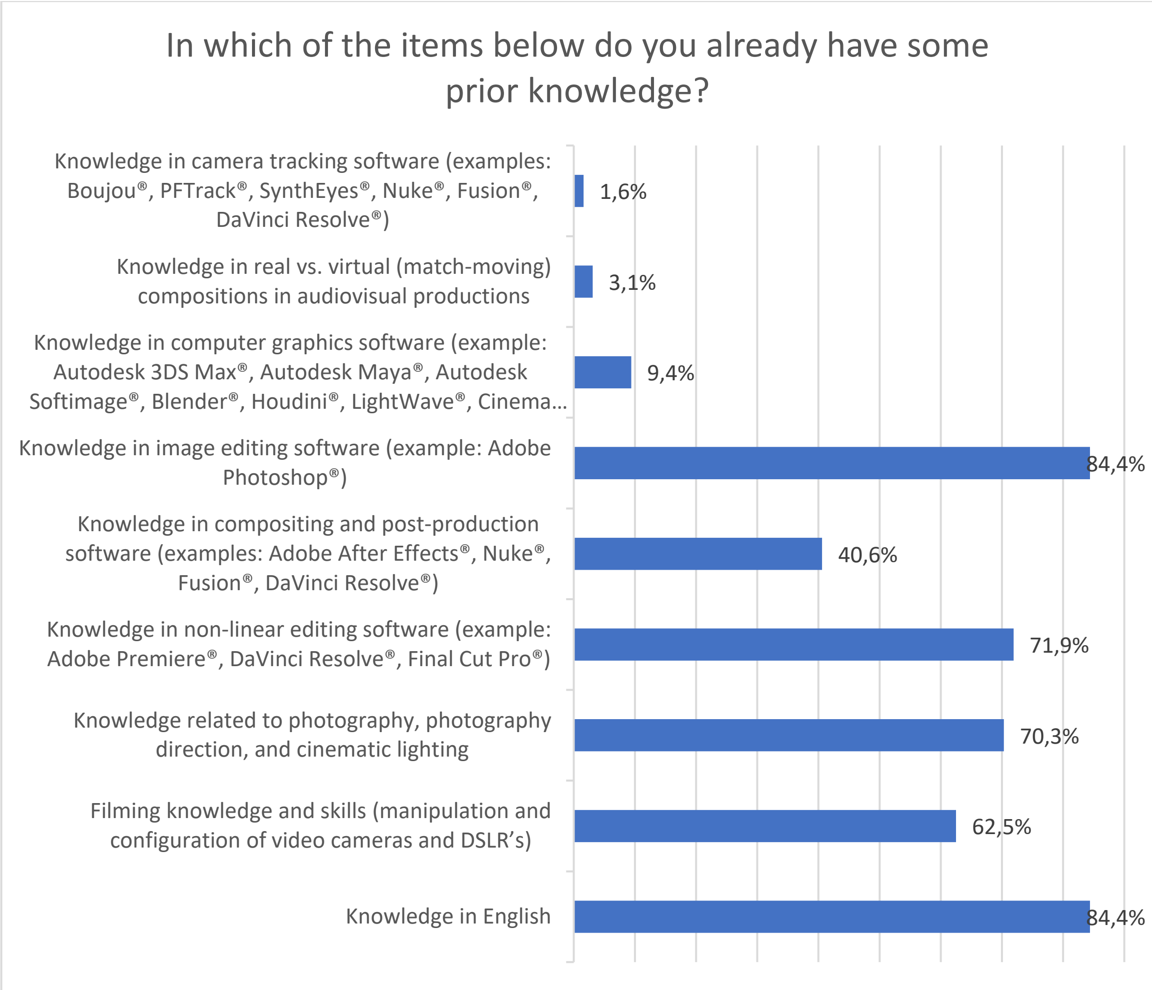


Figure 5.7 - Students' background in certain knowledge, techniques, and technologies

Finally, the use of this preliminary form called "Consultation of interest in participation in mini-course/research" was evaluated as extremely positive and essential to predict the number of students, make methodological changes in advance, know the best schedule to offer the activities, in addition to getting to know the profile of the possible interested better so that pedagogical planning could be done, with greater emphasis on theories and techniques that most would probably present greater difficulties.

5.5. Mini-course

The course was planned and executed in a total of 4 weeks, with activities from Monday to Friday from 19h to 22h (20 total meetings of 3h each, totaling 60 hours of course) and was structured as follows.

The first week was devoted to the presentation and start of theoretical and technical classes for the transmission of the necessary contents for the understanding of how visual effects are produced in audiovisual production; the second week was used for the organization of groups and recording of raw images to be used in practical work, in addition to the necessary measurements and data collections still on the set of recordings; the third week was reserved for the execution of Exercise 01, and the fourth week for the execution of Exercise 02.

At the end of the last meeting, took place the application of the research (forms), and the gathering of the audiovisual products produced individually for further blind analysis. Next, a more detailed descrition of the work developed each week.

5.5.1.Week 01 of Field Work

The main challenge of the first week was to try to equate the knowledge of all the participants because there were students from different classes (semesters), some who had already gone through a greater number of subjects related to audiovisual production, and other students who had gone through a smaller number of subjects. In addition, there was also participation, in a smaller number, of students from other courses, although most of them were students from the Digital Media Communication course.

Also in the first week, in addition to the beginning of classes with theoretical and technical content, it was also explained in the first meetings that the mini-course was part of a research project, and the entire methodological procedure that would be adopted; the artistic and creative limitations that would exist in the execution of the practical exercises due to the methodological process to be followed; and finally, the “Informed Consent Form” was also presented to students, which gives the researcher freedom to use the participants' images, in addition to ethical security.

Next, in Figure 5.8 and Figure 5.9 are photos of the first meeting with students in the computer lab.

Figure 5.8 - First meeting with students in the computer lab

Figure 5.9 - First meeting with students in the computer lab

In the next image (Figure 5.10) the teacher during a lecture on spatial coordinates, types of lights and equipment, units of measurement of color and light intensity.

Figure 5.10 - Students and teacher during one of the classes

5.5.2.Week 02 of Field Work

The second week, as an evolution from the first, served to carry out some practical experiments to exemplify one of the greatest difficulties in the production of **VFX**, which is the correct measurement and recording of the data to be collected during the recordings.

In this way, some demonstrations were performed by the teacher with the participation of the students, to explain how to define the three spatial axes in the scene, how to define the zero point in the three axes, how to measure objects, reference points, elements such as lights and cameras, for recording in analog or digital media for later reproduction and composition in **CGI** software.

In the next images (Figure 5.11, Figure 5.12, Figure 5.13, and Figure 5.14), moments during classes and tests with students.

Figure 5.11 - Students and teacher during one of the classes

Figure 5.12 - Students helping each other during classes

Figure 5.13 - Professor teaching about the importance of using reference spheres for VFX production

Figure 5.14 - Utilization by students of reference spheres and ColorChecker during some tests

After noting the understanding of the content by the participants, they were divided into four groups through a draw. Then the recordings of the raw images were planned and executed in parallel with the data collection. In summary, at the end of the second week, all 4 groups filmed all the necessary images for the execution of the two proposed exercises together.

Each group used or not the tool (**DLO**) to assist in the recording of these captured data, according to the methodological process already presented in section 3.2.2, yet again explained below in Table 5.3 (in the context of the recordings of the scenes for each of the proposed exercises).

Table 5.3 - Division of who would have the aid or not of the tool during the execution of the recordings of the two proposed exercises

Recordings of the Raw Images for the:	Group / With or Without DLO assistance
Exercise A	Group 01 – **With DLO assistance**
	Group 04 – **With DLO assistance**
	Group 02 – **Without DLO assistance**
	Group 03 – **Without DLO assistance**
Exercise B	Group 01 – **Without DLO assistance**
	Group 04 – **Without DLO assistance**
	Group 02 – **With DLO assistance**
	Group 03 – **With DLO assistance**

Through the table above it is possible to note that it was allowed, exclusively at the time of filming and data collection, that students from groups 01 and 04 work together, as well as students from groups 02 and 03.

This possibility was allowed because it did not interfere with the continuity of the exercise, besides allowing a greater discussion and exchange of information among a larger number of students (10 students with the union of two groups, instead of 5 students from each group). That is, instead of 4 groups recording data separately at the time of registration, there were "2 groups", avoiding major logistical problems (in the use of measuring instruments and space and time allocated for the recordings) and also with the aim of avoiding data collection errors.

The next image (Figure 5.15) shows the moment in which the split into groups occurs and the explanation of how will be the collection and subsequent execution of the exercises by each student.

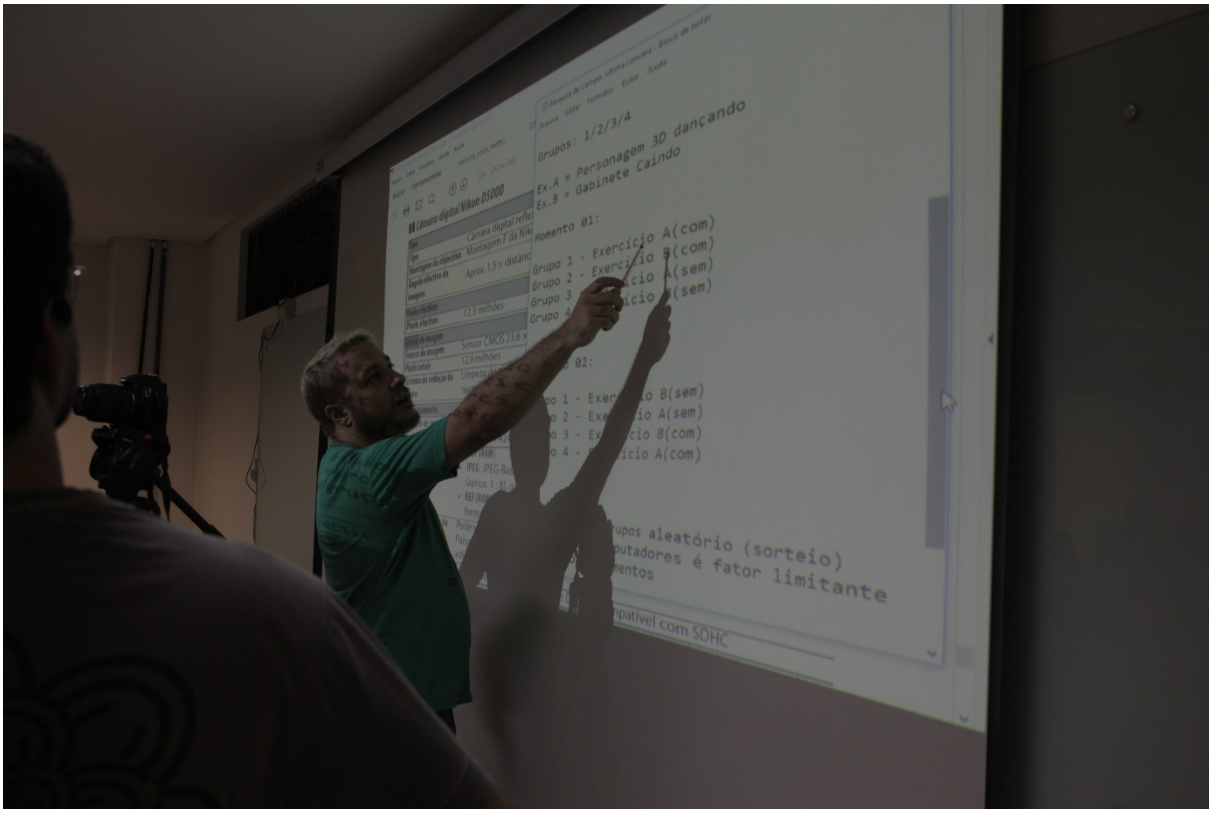


Figure 5.15 - Moment of explanation about the organization by groups, the order of execution, and who whether or not to use the tool in each of the proposed exercises

The definition of students in each group was carried out through a draw. The numbers drawn for each group are shown in Table 5.4 next.

Table 5.4 - Subdivision of students (by number) in groups after drawing

Group	Sorted Numbers
Group 01	03 / 20 / 18 / 08 / 15
Group 02	11 / 09 / 13 / 10 / 04
Group 03	01 / 06 / 05 / 14 / 16
Group 04	02 / 07 / 12 / 17 / 19

5.5.3.Weeks 03 and 04 of Field Work

The third week was used exclusively for the execution of "Exercise A" and the fourth week was used exclusively for the execution of "Exercise B". “Exercise A” is the integration of an animation of a three-dimensional character already modeled and animated, dancing in the middle of the real classroom environment (during the dream, a student's nap), and “Exercise B” the modeling and animation of a computer cabinet being knocked over and falling to the floor, unintentionally, by the same student when she awoke from the dream.

The primary intention was that the proposed exercises had an approximate degree of difficulty of execution, for possible later comparison of the results, and that the students also had the same time for the execution of each exercise.

Despite “Exercise A” already offering the modeled and animated character, something that does not occur in “Exercise B”, the difficulty of repositioning it, resizing it, reorienting it in the environment can be considered of a level of complexity similar to “Exercise B”. In this case, the process of modeling and mapping and animation is simpler, however, it is done entirely by the student, in addition to presenting the same challenges regarding position, dimension, and orientation.

Before choosing such exercises, the proposing researcher consulted and discussed with other teachers and professionals in the field of animation and visual effects on the content to be worked on in both exercises, in order to be interesting and motivating to students; about the need or not to be identical or close to this; and also with respect to the criterion of a similar degree of difficulty to be executed in the same period of time, making the researcher more relaxed by the strategy outlined after this consultation with peers.

To further clarify that each group had to carry out practical activities on computers in a different order, see the next Table 5.5.

Table 5.5 - Order of execution of each of the proposed exercises (A and B) according to each moment (week) for its execution

Week 03 (moment 01)	**Order of execution of the exercises**
Group 01	Exercise **A** - **With** DLO assistance
Group 02	Exercise **B** - **With** DLO assistance
Group 03	Exercise **A** - **Without** DLO assistance
Group 04	Exercise **B** - **Without** DLO assistance
Week 04 (moment 02)	**Order of execution of the exercises**
Group 01	Exercise **B** - **Without** DLO assistance
Group 02	Exercise **A** - **Without** DLO assistance
Group 03	Exercise **B** - **With** DLO assistance
Group 04	Exercise **A** - **With** DLO assistance

Next, the images (Figure 5.16, Figure 5.17, Figure 5.18, and Figure 5.19) show some moments during the execution of the recording activities (still in the second week), to be used later during weeks 3 and 4 to continue the exercises practical.

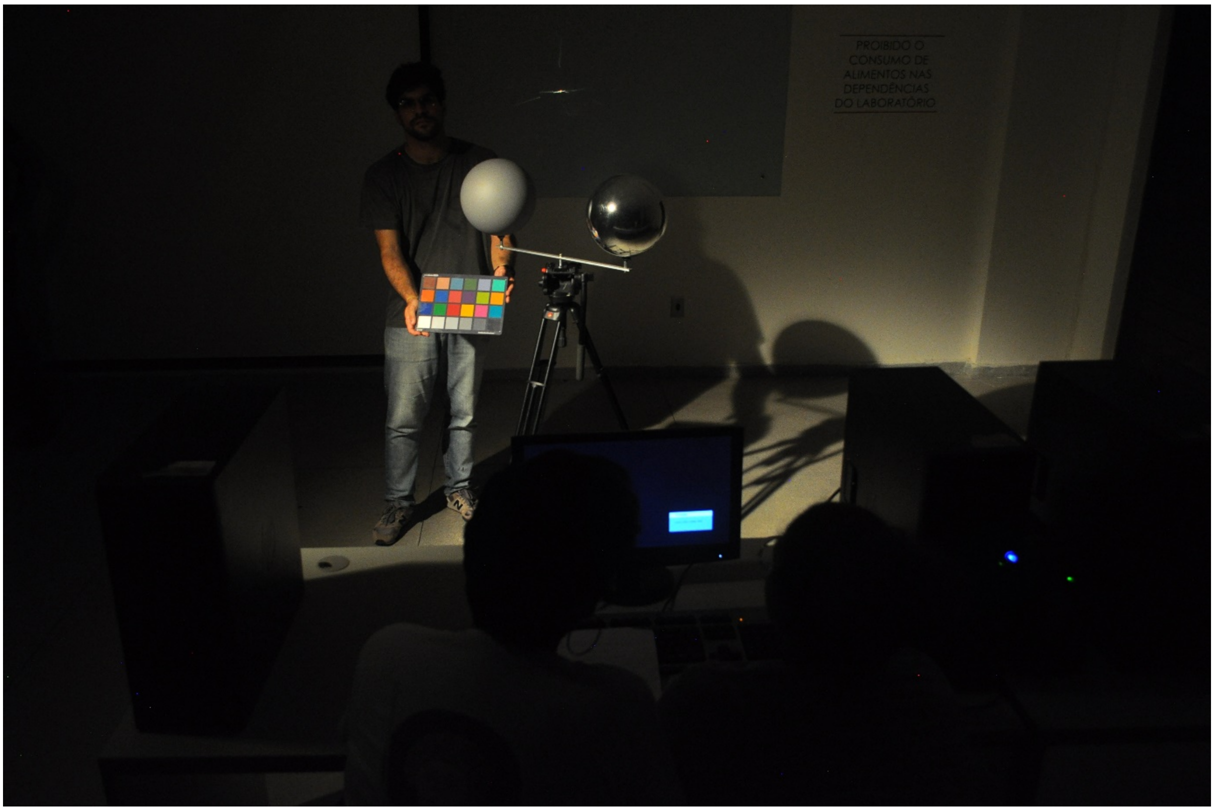


Figure 5.16 - Backstage image of recordings

Figure 5.17 - Backstage image of recordings

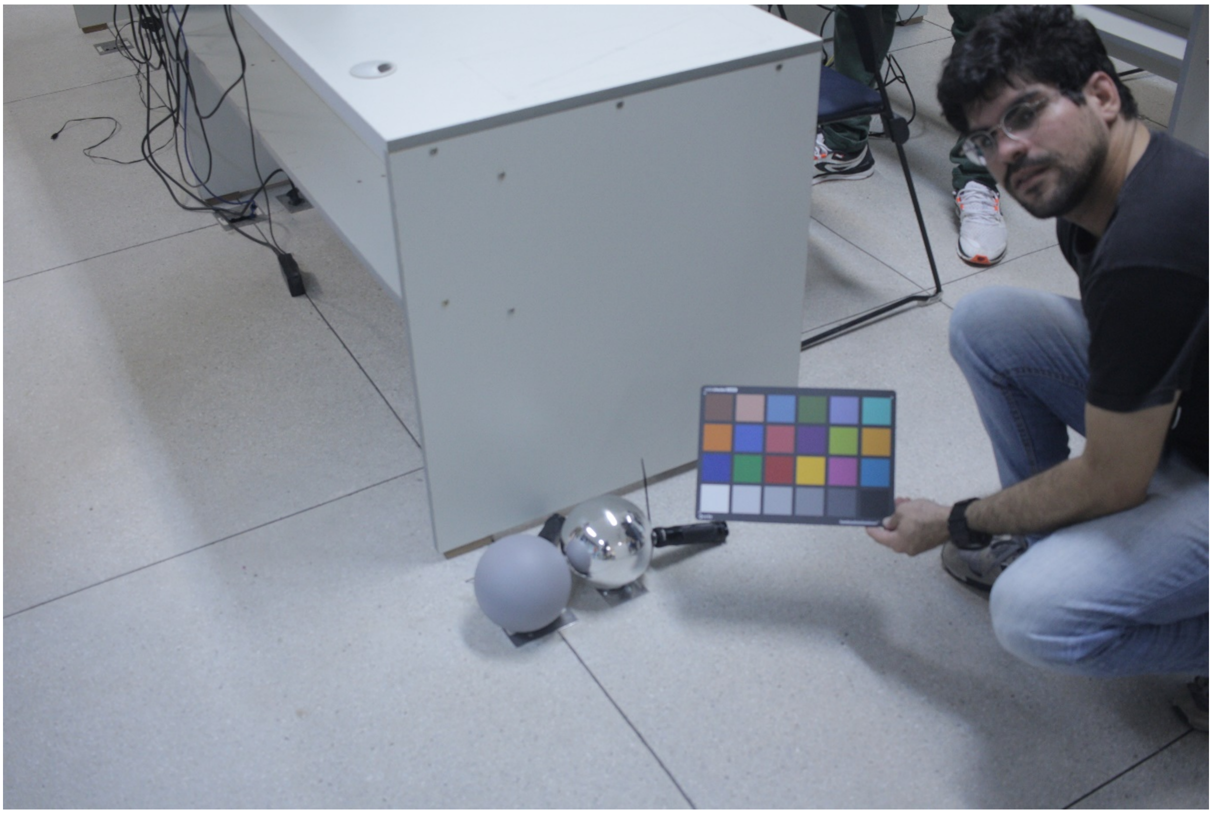


Figure 5.18 - Backstage image of recordings

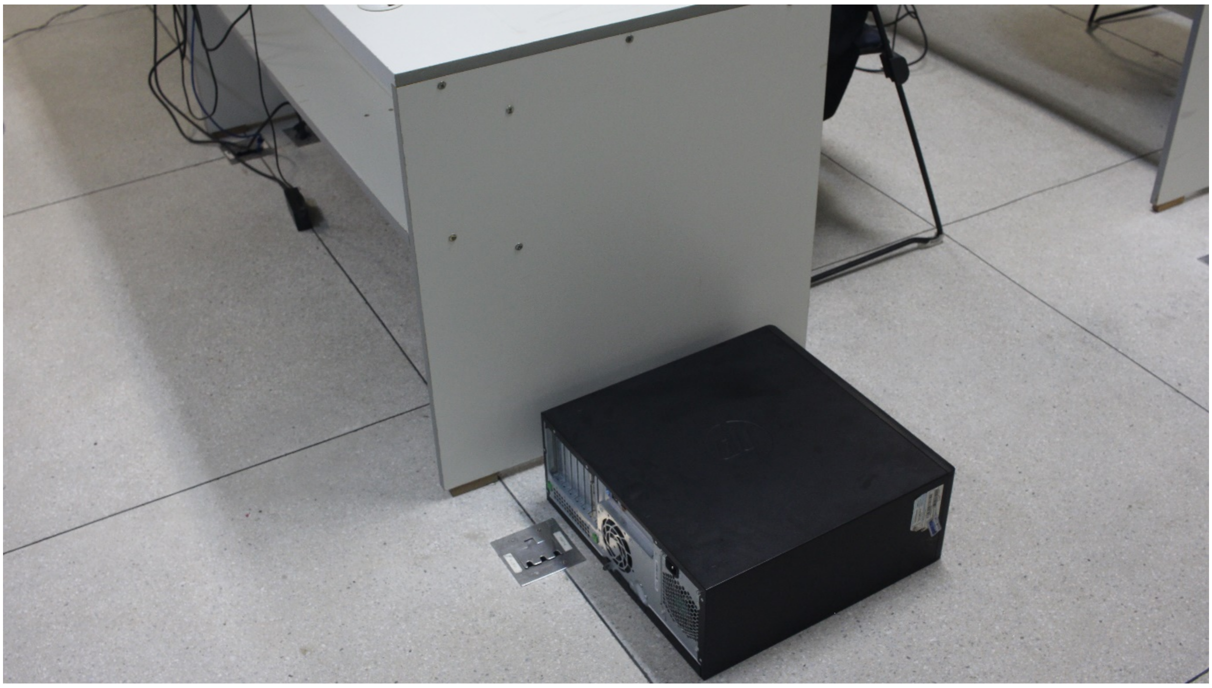


Figure 5.19 - Backstage image of recordings

The next images (Figure 5.20, Figure 5.21, Figure 5.22, and Figure 5.23) are interesting because they illustrate part of the degree of complexity of the data to be collected. They show the notes of students who could not use the tool (**DLO**) to assist them in collecting data for that exercise, and consequently had to do it manually.

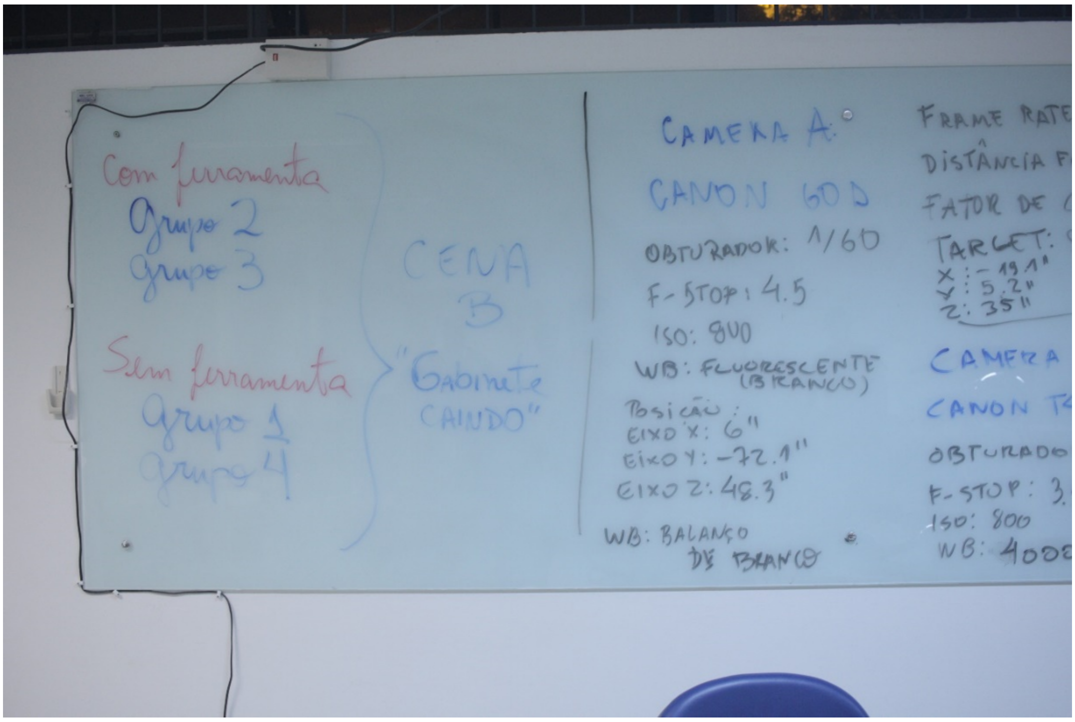


Figure 5.20 - Notes on the whiteboard made by students who do not use the tool at the time of data collection

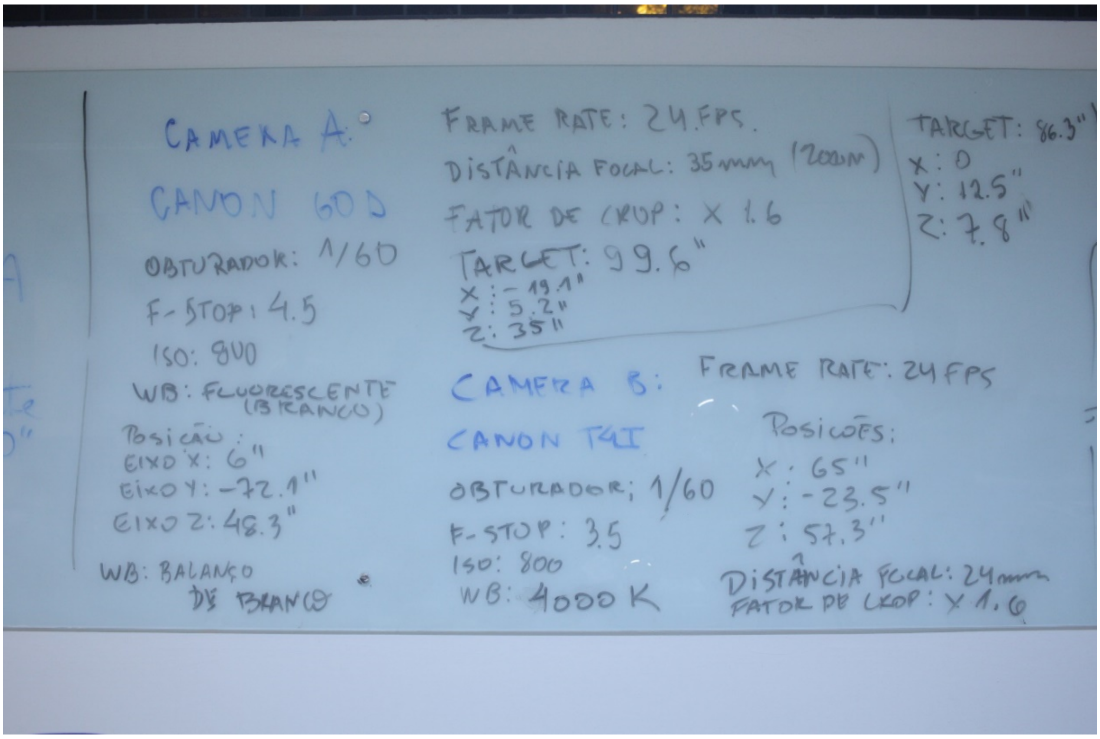


Figure 5.21 - Notes on the whiteboard made by students who do not use the tool at the time of data collection

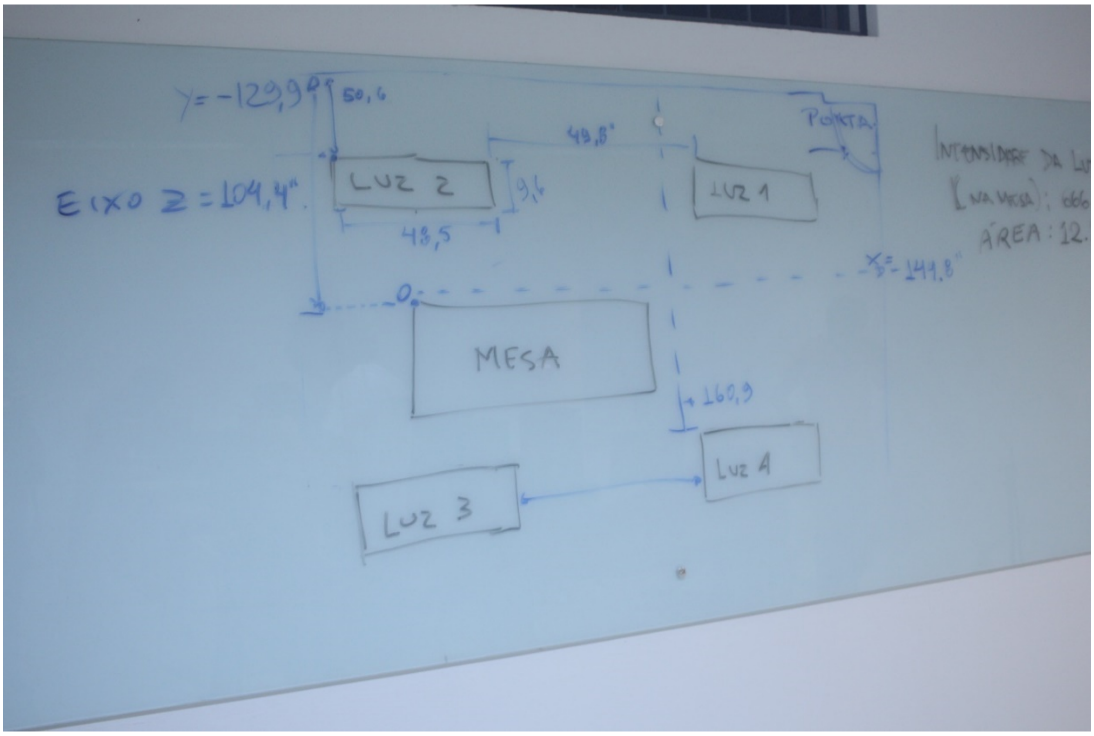


Figure 5.22 - Notes on the whiteboard made by students who do not use the tool at the time of data collection

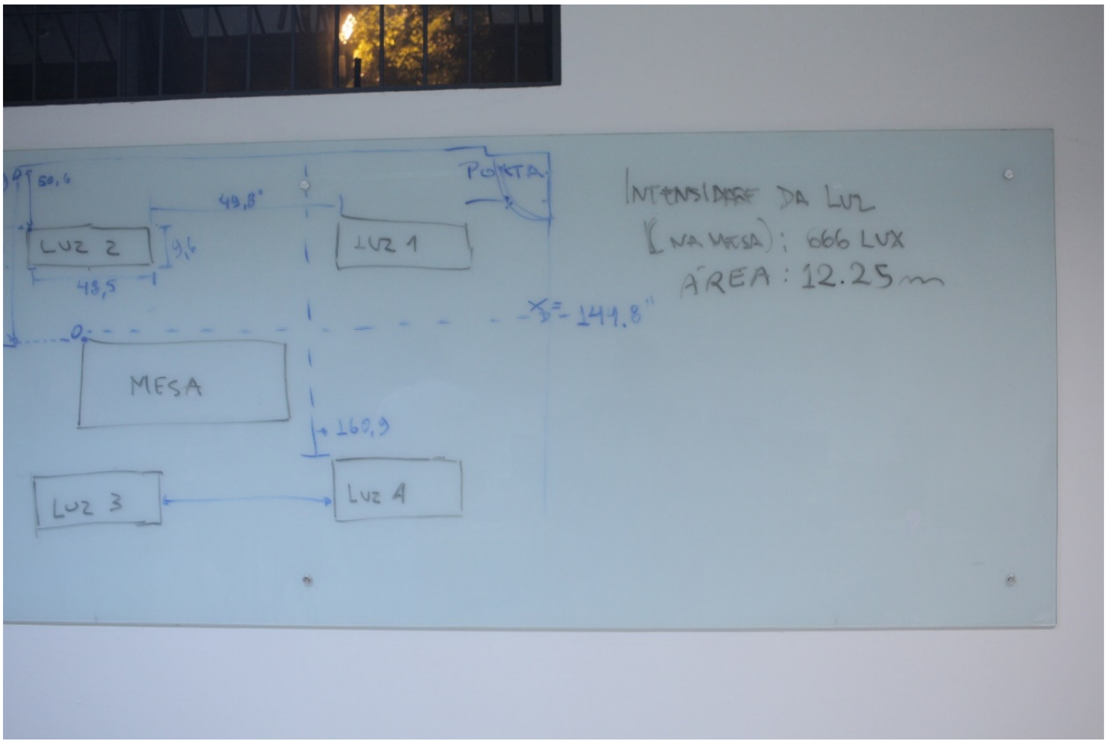


Figure 5.23 - Notes on the whiteboard made by students who could not use the tool at the time of data collection

5.5.4.Last meeting

At the last meeting of the last week, all participants were invited to answer the research forms and share with the professor one digital file (containing the audiovisual material formed by the set of the two exercises performed during the mini-course) collected individually. These audiovisual materials could be submitted to a blind analysis by external evaluators to analyze the hypothesis regarding the possible productivity gain due to the automation offered by the tool.

The next sections will present more details on the stages of application of research forms and organization of audiovisual material for blind evaluation.

5.6. Application of research forms to students

Three forms were produced to be answered by the participants of the mini-course/research, one that covers questions related to the product concept (**DLO** tool produced and tried by the students during the mini-course), and two other forms, one for relevance analysis and another for analysis of the adequacy of the tool, already covered in item 4.1 “Conceptual Research”.

The three research forms were produced to be applied digitally. The first one, related to the Evaluation of the Product Concept, as it was not designed to use the **MaxDiff** method (like the other two), did not have its questions randomly presented, whereas the other forms relevance and adequacy were configured for random presentation, in order to avoid any distortion in the responses due to fatigue.

Initially, analog (print) versions of the forms for presentation to the ethics committee were created, which are only visually different from the digital and online version made available to participating students, but with identical content. The 3 forms used with students can be seen in full in the appendix starting on page 272.

Further details on the forms will be given in the next chapter, where there will be more information about the forms, in addition to containing the presentation of the data obtained through them.

5.7. Organization of the material for blind assessment

The audiovisual material (exercise A and exercise B) produced by each student individually during the mini-course was edited and brought together to form a single audiovisual product. An important observation was made of not identifying the materials, through initial or final credits, or even through graphic characters (**GC**s) in the course of the audiovisual content.

After the students finished the audiovisual material with the **VFX**, they exported the files in digital format (file extension * .mp4), with each student's name as the file name, and after copied them to the teacher's computer.

The names of the files were replaced by numbers, to avoid any identification by the evaluators, and sent to the blind evaluation.

A text file was created containing instructions to the evaluators. This document of instruction to the evaluators and the form used by them for this stage of the blind analysis can be seen in the appendices on pages 308 and 309 respectively.

Two professors from the **UFPB** Digital Media Communication course who work directly in the audiovisual area and a non-academic professional, who works in the audiovisual market in Lisbon, Portugal, were invited to carry out the blind evaluation of the practical exercises. The objective was to carry out an evaluation that contemplated both the product from the perspective of a teacher, as well as a professional working in the market, despite being audiovisual products produced in a teaching context.

These evaluators, therefore, received the audiovisual materials and the instructions, watched, evaluated, and recorded their notes through the online and offline spreadsheets.

5.8. Parallel research with teachers

According to Neto, Biagiotti, Baldessar and Siqueira (Revisão Sistemática de Metodologias de Avaliação de Objetos de Aprendizagem, 2017), it is of great relevance to carry out research on **DLO** also with other teachers in the area with the potential to use the tool. With this intention, the following procedures were carried out.

> In general, the methods found have their tools aimed only at collecting feedback from end-users, students. However, according to Morgado, Ruiz, and Peñalvo (2007), the evaluation of OA must consider both student users and experts (teachers, instructional designers) who will use the materials. (Neto, Biagiotti, Baldessar, & Siqueira, 2017, p. 11)

Through the website "e-MEC" [15] created by the Ministry of Education (MEC) of Brazil, it is possible to have access to the "National Register of Courses and Higher Education Institutions". Thus, it was possible to research all private and public undergraduate courses in Brazil that have a correlation with audiovisual production and computer graphics (animation and design) that could perhaps offer some discipline that addressed the **VFX** theme, that is, interactions between audiovisual production and computer graphics.

All undergraduate courses related to audiovisual as cinema, broadcasting (rádio and tv), animation, and design were then researched. During this research, which took a long time, we tried to understand a little about each one of these courses and locate the full name of the respective course coordinator, their title (Ph.D. or M.Sc.), find the full name of the institution and the course, in addition to locating the contact email of the respective course coordinator.

Finally, not only undergraduate courses in Brazil were collected, but also technical courses and training courses.

Information on higher education institutions was also searched through the website of the "General Secretariat for Education and Science"[16] from Portugal, however, the Portuguese website does not provide a list of courses, only technical information such as legislation. In this way, the information

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[15] Website containing the "National Register of Courses and Higher Education Institutions" in Brazil: http://emec.mec.gov.br/

[16] Website of the General Secretariat for Education and Science of Portugal: https://www.sec-geral.mec.pt/

for Portugal was freely searched on search engines considering both higher and technological education levels.

Table 5.6 next presents an overview of the number of courses that could be located for contact.

Table 5.6 - Types of courses in Brazil and Portugal, and the number that were contacted for the research with teachers about the tool

Course type	**Number found**
Higher Education Courses (Undergraduate) - Brazil	159
Technological Level Courses - Brazil	7
Training Courses - Brazil	14
Higher Education Courses (Undergraduate) - Portugal	19
Technological Level Courses - Portugal	1
Total contacts	200

In the appendices, starting on page 311, it is possible to find the said table, where it is possible to check the name of the contacts, courses, institutions, and the respective e-mails located and used later. Although more undergraduate courses were found in Brazil, a rough comparison was made between the size of the population of the two countries (Brazil 209.5 million inhabitants in 2018[17] and Portugal 10.28 million inhabitants in 2019[18]), it can be said that proportionally to the number of inhabitants, Portugal has 243% more undergraduate courses related in some way to these areas than Brazil, being, therefore, numerically well represented.

After this research was completed by the institutions and the respective coordinators of each of these courses with their contacts, a document was elaborated for use as a direct mail, in order to personalize each of the e-mail messages to be sent, streamlining and automating the work at the same time.

The model used to send direct mail to all contacts listed in the table, can be seen on page 318 of the appendices.

These coordinators are invited to know about the tool (**DLO**) created to assist them in the process of teaching visual effects, and send links to both the website with information about the doctorate and the tool, such as the link direct to access the tool. Consequently, the importance of participating in the research (evaluating the tool) is explained and it is presented the 3 steps necessary to be able to participate in the research.

Step 01 - Get to know the tool by accessing the website through the link sent, where you can also see the instructional support structure for using the tool in an educational environment.

Step 02 - Access, read and digitally sign the “Informed Consent Form” (**ICF**), indispensable for ethical procedures together to the research ethics committee (a lot of time was invested to create a digital and online system where the teacher could read the document, digitally sign it and receive a copy of the signed document at the same time that the research coordinator also received another copy of the signed document for archiving).

[17] Data extracted from "World Bank"
[18] Data extracted from “Eurostat, Demographic Indicators”

Step 03 - Respond to the research forms that were made available through links as well (same forms created for use with students, however with adaptations in the statements of the questions just to adapt the guidance to teachers).

In summary, this e-mail message was created, containing a presentation with the course coordinator, a request to forward the e-mail to teachers in the areas in the course, a presentation to these teachers, and an invitation to know about the tool and participate in the research.

The intention with this direct contact with the course coordinators was to reach a larger number of teachers, as each course coordinator could forward the respective invitation to more than one teacher, this way if, for example, there was 1 teacher from each institution participating, there would be 200 participants, with 2 teachers per institution participating, this number could reach 400 participants.

In the end, were sent a total of 219 personalized emails.

Chapter 6 - DATA PRESENTATION AND ANALYSIS

Four different forms were elaborated to be used during the research, three of them for students and teachers (with adaptations) and one for evaluators.

- Form - Product Concept (1 version for students / 1 version for teachers)
- Form - Relevance (1 version for students / 1 version for teachers)
- Form - Adequacy (1 version for students / 1 version for teachers)
- Form - For blind evaluation of the practical exercises (for evaluators)

As already mentioned, the models of the four forms used in the research are found in the appendices (the three used with students starting on page 272 and the one used for blind assessment starting on page 309). According to Marconi and Lakatos "The form is one of the essential instruments for social research, whose data collection system consists of obtaining information directly from the interviewee" (Marconi & Lakatos, 2003, p. 212). With this aim, forms were chosen because thinking about the statistical techniques to be employed and the types of questions to be elaborated, it would be a possible format to be adapted to these needs, allowing the correct presentation of the questions and reflections to be answered by the interviewees.

The correct configuration of the forms was tested extensively before the effective use by the research participants, in order to allow obtaining clearer, more reliable, and complete data, avoiding damages to the research result.

Starting with the categorization of the data, the choice for quantitative research helps the process of analysis and presentation of the results by already presenting in advance what will be evaluated (concept, relevance, and adequacy), as commented by Gil "In quantitative research, the categories are often established a priori, which greatly simplifies the analytical work" (Gil, 2002, p. 134). In summary, the analysis becomes relatively simpler (despite the necessary calculations that are often complex) than when compared to qualitative research.

As already mentioned in the methodological part, statistics will be the great ally in the presentation and analysis of data, and these will be presented ahead in a section for each of these forms used, in addition to the other two stages of the research, the crossing between the forms relevance and adequacy and then the experiment carried out using blind analysis.

For the elaboration of the modeling of the questions and treatment of the collected data, specific software was used as IBM **SPSS** and **XLSTAT** (Statistical Software for Excel by Addinsoft) for **MaxDiff**. Furthermore, we emphasize the importance of the techniques employed, as evidenced in Gil's quote below.

> In experimental research, generally, one uses statistical analysis. The development of the statistical techniques has been remarkable and its applicability in the experimental research so adequate that nowadays one cannot fail to use them in the data analysis process. (Gil, 2002, p. 100).

Regarding the forms that follow, the first form (Form - Product Concept) and the last form (Form - For blind evaluation of practical exercises) present the questions in the same order in which they are presented in the body of the thesis, the other forms that use the **MaxDiff** technique were programmed to present all questions in a randomized way for each one of the research participants, so that there would be no problems due to the order of presentation and relative fatigue of the respondents due to the sequence of presentation of questions (Anderson, 2001), (Shadish, Cook, & Campbell, 2002).

The mini-course given to the students, an integral part of the research, started with 20 participants in total, but during the 4 weeks there were dropouts, thus, only completed the course in full and answered the forms 14 participants at the end.

6.1. Form - Product Concept

The first Form aimed at an analysis of the concept of the product, bringing the relevance, differentiation, credibility, and intention of use to be evaluated in a linear scale of zero to ten points by the respondents (Likert Scale or Décis) (Martins & Theóphilo, 2017) besides other questions that used other scales for the answers.

For the representation of data analysis, in addition to the values assigned by each participant, it uses the sum of the number of respondents who chose the 4 options with the highest values (grades 7 to 10) divided by the total number of respondents, reaching the "Top 4" percentage. Also, the sum of the number of respondents who chose the 4 lowest value options (grades from 0 to 3) divided by the total number of respondents, reaching the "Bottom 4" percentage.

__Question 01__: Evaluate below how much you consider this tool **relevant** for students of courses related to audiovisual production.

As can be seen in the graph (Figure 6.1) below, of the 14 respondents, 57.1% (8 participants) rated the concept 10 (maximum value), the concept 9 was attributed by 14.3% (2 participants), the concept 8 was attributed by 21.4% (3 participants) and only 7.1% (1 participant) attributed the concept 6.

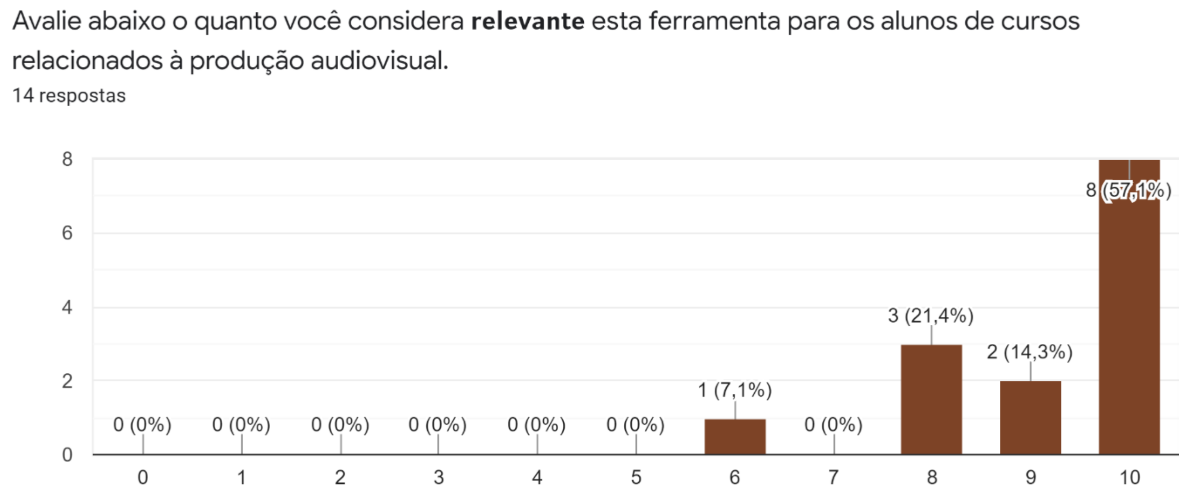

Figure 6.1 - Relevance on a scale of 0 to 10

It is observed that 92.9% of the participants (13 participants) attributed a value above 8 for the relevance of the tool. Using the simple arithmetic mean of the marks awarded, the evaluation reaches **9.14** on a scale from zero to ten (standard deviation of 1.23).

It can be concluded, therefore, that the participants evaluated the tool with **high relevance** for students of courses related to audiovisual production, with a percentage of Top 4 responses of 92.8%, without negative ratings (Bottom 4 = 0%).

<u>Question 02</u>: Evaluate below how much you believe this **tool is different** from the others you already know.

The second question about the differentiation of the tool in comparison with others that the respondent could already know. The result obtained (Figure 6.2) was the following: 42.9% (6 participants) attributed the concept 10; 21.4% (3 participants) attributed the concept 9; 21.4% (3 participants) attributed the concept 8; 7.1% (1 participant) attributed the concept 7; and 7.1% (1 participant) attributed the concept 6.

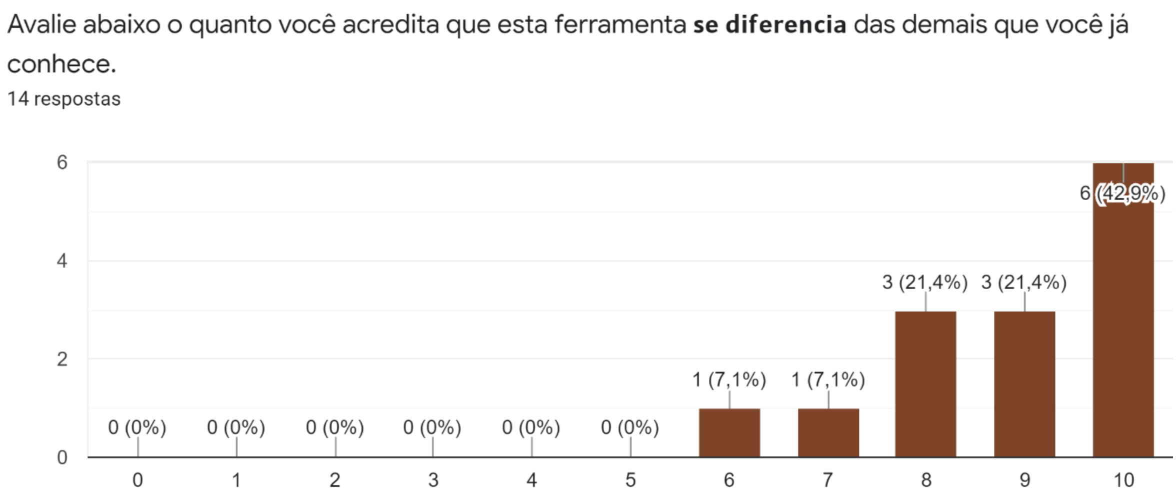

Figure 6.2 - Differentiation on a scale of 0 to 10

In this question, it is possible to note, therefore, that 85.7% (12 participants) attributed values greater than 8 on a scale from zero to ten, in addition, the rest of the participants still attributed values greater than five (the average value in the table). Using the simple arithmetic mean the value assigned to this question is **8.85** on a scale from zero to ten (standard deviation 1.29).

Thus, it is possible to conclude that in the question of differentiation, the participants considered the tool to be **highly differentiated** from others that they have already had contact, with a percentage of Top 4 responses of 92.8%, without negative ratings (Bottom 4 = 0%).

<u>Question 03</u>: Evaluate below what is your perception of the **credibility** transmitted by the tool.

As can be seen in the graph (Figure 6.3) next, of the 14 respondents, 42.9% (6 participants) rated the concept 10 (maximum value), the concept 9 was attributed by 14.3% (2 participants), the concept 8 was attributed by 14.3% (2 participants), the concept 7 was attributed by 14.3% (2 participants), 7.1% (1 participant) attributed the concept 6 and 7.1% (1 participant) attributed the concept 5.

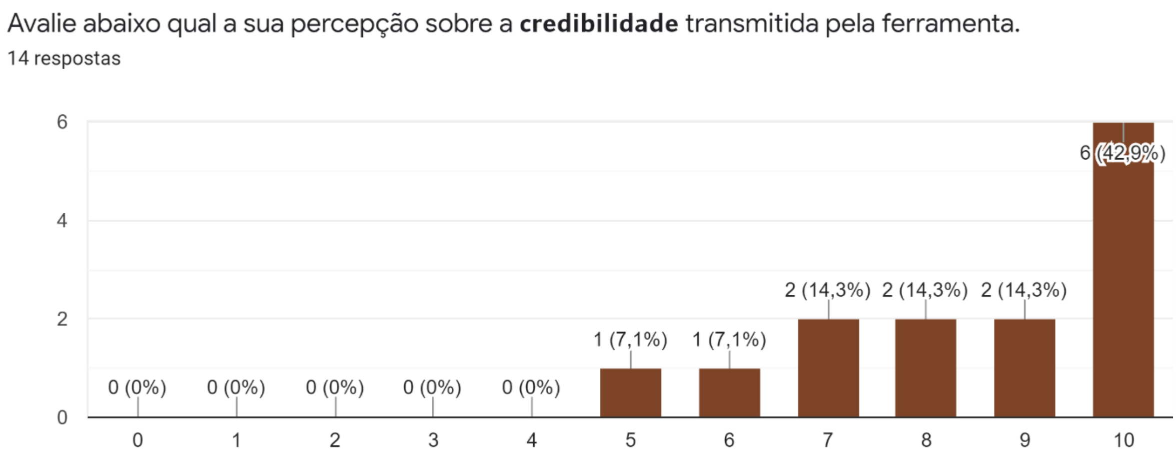

Figure 6.3 - Credibility on a scale of 0 to 10

In this question, almost half of the participants rated the tool with the highest score, the remainder evaluated with concepts that were distributed between the values five to nine. Using the simple arithmetic mean of the marks awarded, the evaluation reaches **8.5** on a scale from zero to ten (standard deviation of 1.69).

The data lead to the conclusion that the tool was evaluated with **high credibility** by the participants, with a percentage of Top 4 responses of 85.8%, without negative evaluations (Bottom 4 = 0%).

Question 04: Please indicate below how you evaluate your **intention to use** the tool.

As can be seen in the graph (Figure 6.4) below, of the total respondents, 28.6% (4 participants) attributed the concept 10; 7.1% (1 participant) attributed the concept 9; 21.4% (3 participants) attributed the concept 8; 28.6% (4 participants) attributed the concept 7; and 14.3% (2 participants) attributed the concept 5.

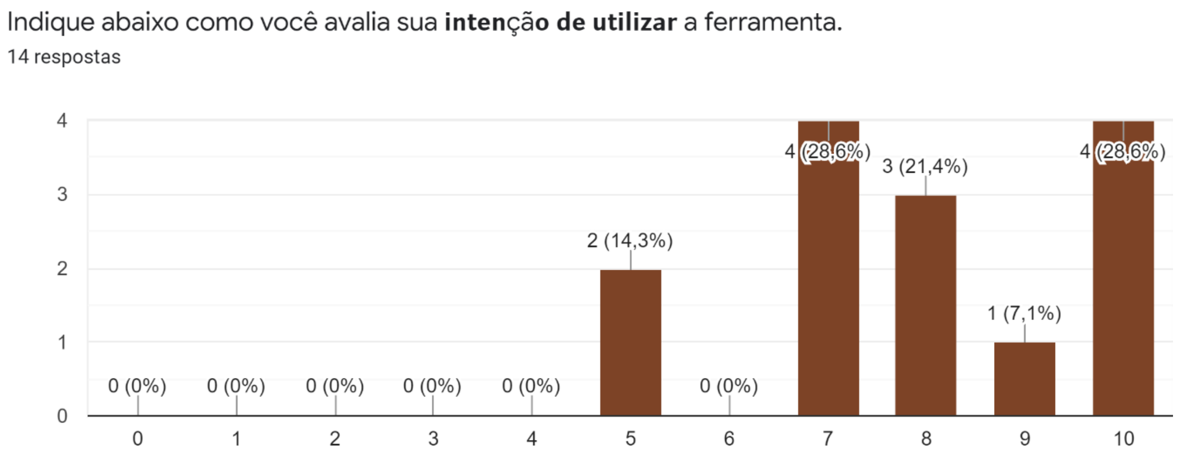

Figure 6.4 - Intention to use on a scale of 0 to 10

In this question, it is possible to note that the majority of respondents distributed their assessments in this regard between concepts 7 and 10. Using the simple arithmetic mean the value assigned to this question was **7.92** on a scale from zero to ten (standard deviation of 1.73).

In this way, it is possible to conclude that on average the participants rated high **the intention to use the tool,** with a percentage of Top 4 responses of 85.7%, without negative evaluations (Bottom 4 = 0%).

For questions 05 and 06, an agreement scale from zero to ten points was also used, where zero has the meaning of "totally disagree" and on the other opposite of the scale the value ten has the meaning of "totally agree".

In these next questions, the results obtained were as follows:

<u>Question 05</u>: "Learning, having competence and qualification to produce more elaborate visual effects (integration between real and virtual images in audiovisual) **can improve my possibilities of insertion in the labor market**".

As can be seen in the graph (Figure 6.5) below, of the 14 respondents, 78.6% (11 participants) rated the concept 10 (maximum value), the concept 9 was attributed by 7.1% (1 participant), the concept 8 was assigned by 7.1% (1 participant) and concept 7 was also assigned by 7.1% (1 participant).

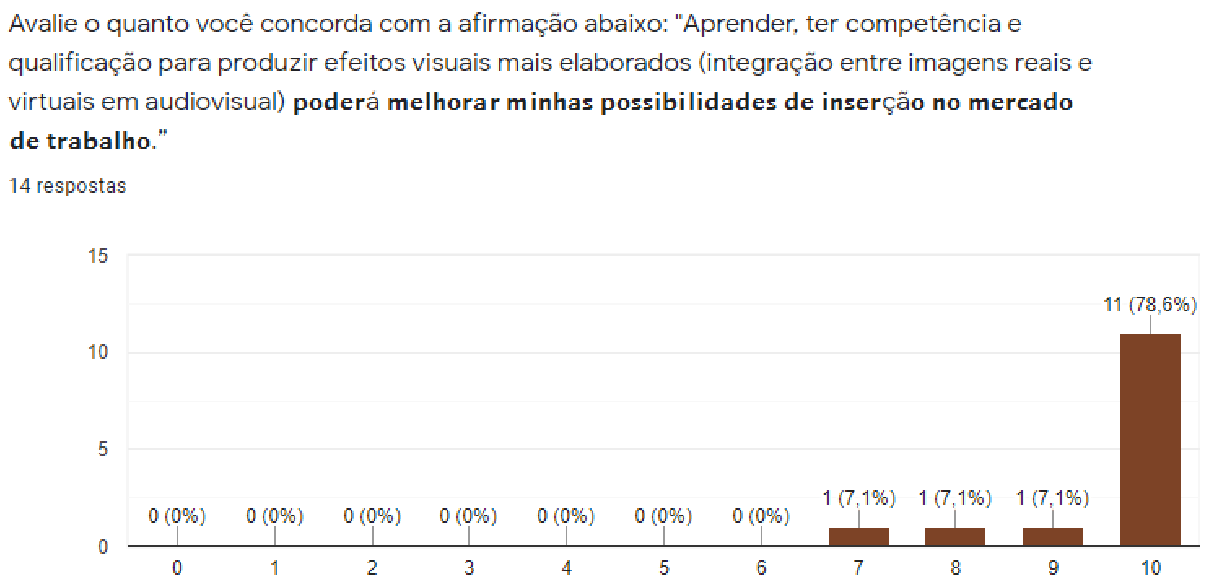

Figure 6.5 - Concordance with statement 01 of 02 on a scale of 0 to 10

The participants agreed very strongly with the statement. With a Top 4 response rate of 99.9%, no negative evaluations (Bottom 4 = 0%). Using the simple arithmetic mean of the assigned scores, we arrive at the **9.57** assessment on the scale of zero to ten (standard deviation of 0.93).

Question 06: "Learning, competence, and qualification to produce more elaborate visual effects (integration between real and virtual images in audiovisual) **allow me to have greater creative freedom in my audiovisual projects**".

As can be seen in the graph (Figure 6.6) below, of the 14 respondents, 78.6% (11 participants) rated the concept 10 (maximum value), the concept 9 was attributed by 7.1% (1 participant), the concept 8 was assigned by 7.1% (1 participant) and concept 7 was also assigned by 7.1% (1 participant).

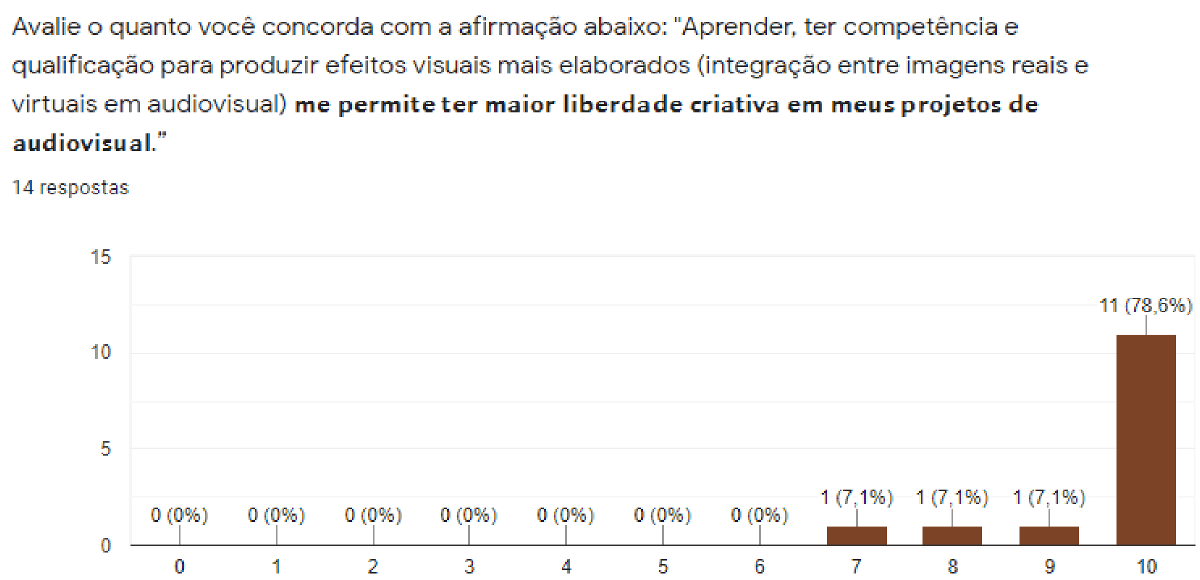

Figure 6.6 - Concordance with statement 02 of 02 on a scale of 0 to 10

The participants agreed very strongly with the statement, with a Top 4 response rate of 99.9%, no negative evaluations (Bottom 4 = 0%). Using the simple arithmetic mean of the assigned scores, we arrive at the **9.57** assessment on the scale of zero to ten (standard deviation of 0.93).

For question 07 a linear scale of zero to ten points was also used, however, the assignment of the value itself was not used, but a representation where zero has the meaning of "would not recommend with certainty" and in the other opposite of the scale the value ten has the meaning of "would recommend with certainty".

In this next question, the result obtained was as follows:

<u>Question 07</u>: Participants **would highly recommend** the tool to a colleague, relative or friend.

As can be seen in the graph (Figure 6.7) next, of the 14 respondents, 50% (7 participants) rated the concept 10 (totally agree), the concept 9 was attributed by 21.4% (3 participants), the concept 8 was assigned by 14.3% (2 participants), concept 7 was assigned by 7.1% (1 participant) and concept 6 was also assigned by 7.1% (1 participant).

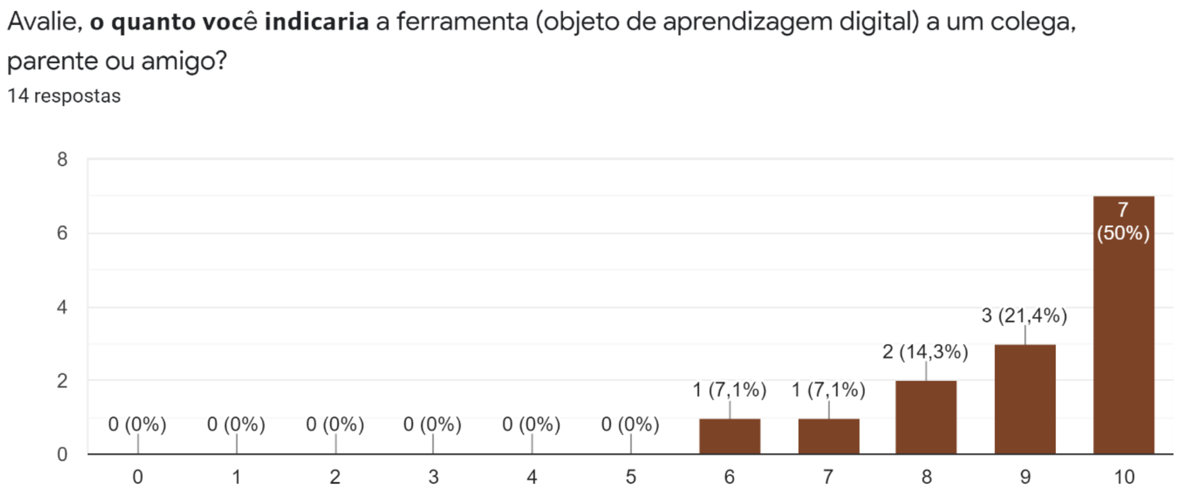

Figure 6.7 - Indication of the tool to a colleague, relative or friend on a scale of 0 to 10

It is noted that exactly half of the participants attributed the maximum value to the questioning, responding as “I would recommend it for sure”. The remaining respondents all used values greater than six on a scale of zero to ten, with a greater concentration between values eight and nine, with a Top 4 response rate of 92.8%, no negative evaluations (Bottom 4 = 0%). Using the simple arithmetic mean of the assigned scores, we arrive at the **9.0** assessment on the scale of zero to ten (standard deviation of 1.3). It can be concluded, therefore, that the participants **would recommend and/or indicate** the tool to a colleague, relative, or friend.

This question, however, is based on the “**Net Promoter Score**” (**NPS**) (Reichheld, The One Number you Need to Grow, 2004), (Reichheld & Markey, 2011), methodology used to measure public satisfaction and aims to assess how well the company or product is recommended by the so-called definitive question.

It is a satisfaction survey methodology created in 2003 by Frederick F. Reichheld which, as it is simple and easy to apply, ended up being adopted by most companies, becoming a universal method for assessing customer satisfaction. For this reason, **NPS** is considered one of the most important key performance indicators (KPI) and fundamental for strategic planning and decision making.

This research method is very efficient to find out if the customer is satisfied with the product and/or service offered, as it assumes that the respondents would not indicate something that they consider to be of poor quality/not relevant to someone they like. Through the answer, it is possible to better understand the rational and emotional factors that permeate the experience.

As explained in the figure (Figure 6.8) below, for the calculation according to the **NPS**, it is necessary to divide the research participants into 3 categories according to the marks they assigned: Detractors grades from 0 to 6, Neutral grades 7 or 8, and Promoters grade 9 or 10.

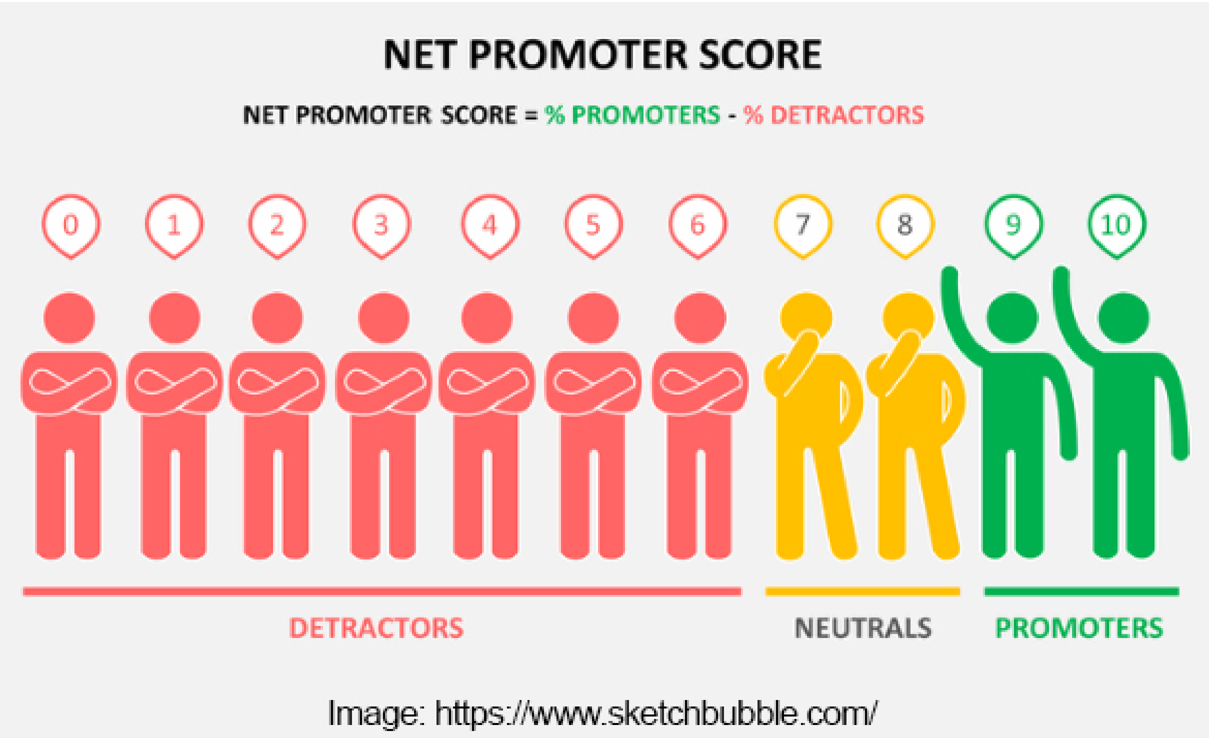

Figure 6.8 - The participants divided into three categories according to the marks awarded

As a result, we obtain the following numerical proportion, also illustrated by the graph (Figure 6.9):

- Promoters: 10 participants
- Neutral: 3 participants
- Detractors: 1 participant

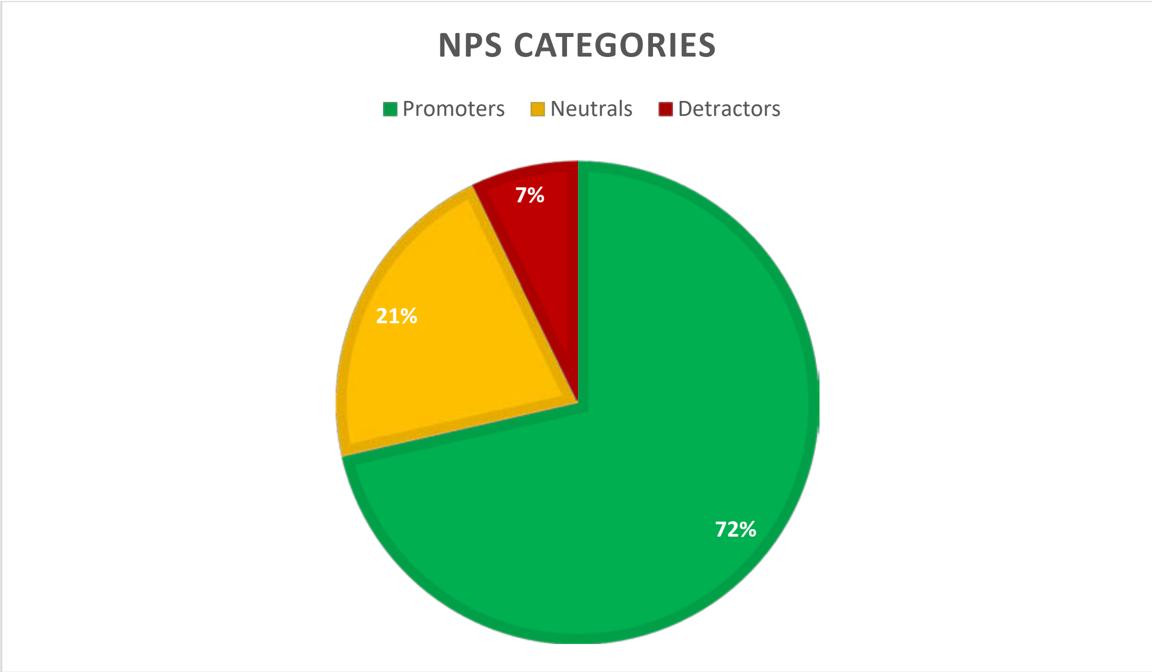

Figure 6.9 - The proportion of participants according to the NPS categories

Calculation:

NPS = (promoters **-** detractors) **/** total number of respondents

NPS = (10 -1) **/** 14

NPS = 64%

The standard scale, illustrated by the Figure 6.10 next, to serve as a parameter for the assessment is as follows:

- Zone of Excellence (Excellent): 75% to 100%
- Quality Zone (Very good): 50% to 74%
- Improvement Zone (Reasonable): 0% to 49%
- Critical Zone (Bad): -100% to -1%

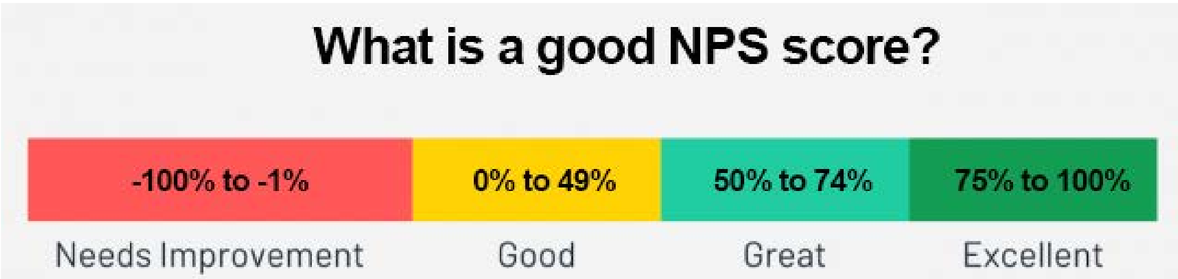

Figure 6.10 - Illustration of the scales for evaluating the NPS score

As the **NPS** value computed in the question was **64%**, by the standard scale we can verify that the index is within the **Quality Zone**, a good result since it is not classified in the Critical Zone or in the Improvement Zone (where it would require interventions and adjustments, deeper and/or structural adjustments). In addition, it is also perceived that there is scope for the product to develop, in order to seek to fit into the Zone of Excellence in the future, using the information gathered in the next Forms for its improvement.

Question 08 of this first form was the only one that did not use a linear scale from zero to ten. When requesting a comparison between the concept seen from the created tool and what is currently on the market, a five-point linear scale was used where one could choose between the following comparative statements.

5 - much better than what currently exists
4 - better than what currently exists
3 - neither worse nor better than what already exists currently
2 - worse than what already exists currently
1 - much worse than what already exists currently

In this last question of this first form, the result obtained was the following:

Question 08: Taking into account what you saw of this concept and considering what currently exists on the market for these objectives (pedagogical support for teaching visual effects), you would understand that this product would be (possible responses on the chart and responses obtained on the chart and described below):

As can be seen in the graph (Figure 6.11) below, of the 14 respondents, 14.3% (2 participants) responded with the statement “5 - much better than what currently exists”, 71.4% (10 participants) responded with the statement "4 - better than what currently exists ", and 14.3% (2 participants) responded with the statement "3 - neither worse nor better than what already exists currently ".

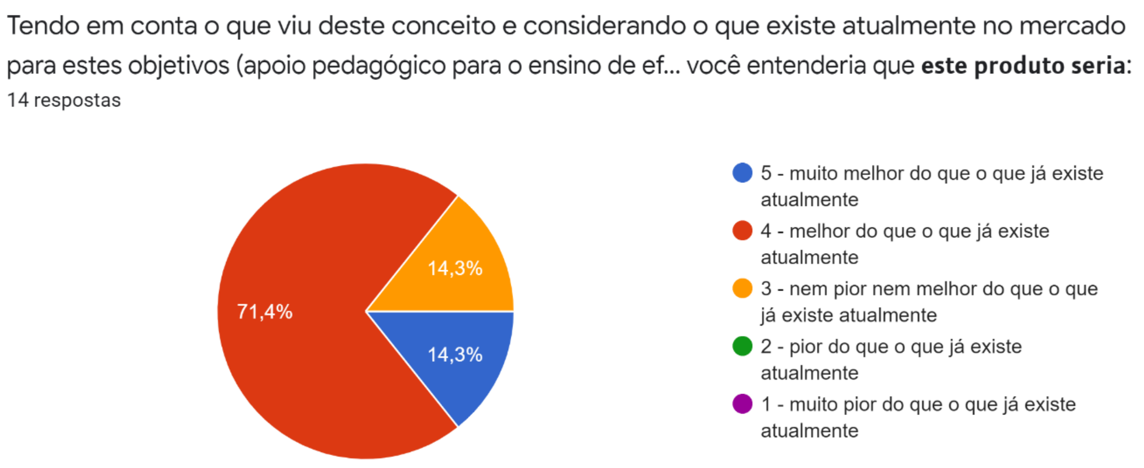

Figure 6.11 - Comparison regarding the concept of the tool and what currently exists on the market for the same objectives

For this question, due to a smaller latitude of options to the response from (1 to 5 instead of 0 to 10), Top 2 and Bottom 2 were used, with Top 2 response rate of 85.7%, no negative evaluations (Bottom 2 = 0%)

Based on these responses it is noted that no participant understood that the product (tool) is worse or much worse than what already exists today. Two participants 14.3% answered who is neither worse nor better than what already exists today, the rest, **85.7% answered that they understand that the concept of the product they saw is better** (71.4%) **or much better** (14.3% %) **than what already exists today**.

6.2. Form - Relevance

The second form is an evaluation of the product's characteristics regarding its relevance. This form used an experimental aspect methodology, with wide application in academia and Marketing, for the purposes of a consumer study: Maximum Difference Scaling (**MaxDiff**) (David, 1969), (Louviere, 1991), (Louviere, 1993), (Marley & Louviere, 2005), (Louviere, Flynn, & Marley, 2015).

MaxDiff starts with a long-standing theory of mathematical psychology with very specific assumptions about how people make choices: it assumes that respondents evaluate all possible pairs of items within the displayed set and choose the pair that reflects the maximum difference in preference or importance. It can be thought of as a variation of the Thurstone peer comparison method (A Law of Comparative Judgment, 1927) where it is possible to make a ranking of attributes to know which are the most and least important/suitable/distinctive.

For the creation of these questions in the **MaxDiff** model, 39 attributes were created, 17 related to the design of the tool, and another 22 related to pedagogical questions related to the creation of digital learning objects. The thesis discusses in greater depth about the creation/selection of these attributes in the section 4.1. Conceptual Research (page 63).

After these 39 ready attributes, specific software (**XLSTAT**) was used to create the questions in the **MaxDiff** model. To create this Form of relevance in the **MaxDiff** model, all 39 attributes created were used. All attributes were randomized by the **MaxDiff** survey application that was configured to create 30 comparative questions with 4 attributes each question (application makes the statistical distribution of attributes to the questions). Students had to mark in each of the 30 questions on the form, which of the 4 features he considered the most and least relevant. The 30 questions were randomly presented to each student participating in the survey to avoid bias related to fatigue if it had a single order for presentation the questions.

Although it was not possible to reach a larger number of subjects, which limits the analytical robustness, the research model brought good results.

Analysis of relevance form data

All 39 attributes used in the questions on the relevance form are shown in Table 4.1, on page 65, where they can be consulted.

As a result, it was verified that the attributes selected as the ***most relevant attributes*** of the tool were (Table 6.1):

Table 6.1 - Attributes with most relevance of the DLO

Attributes	Total average relevance
Efficiency - a perception of being competent, productive, of achieving the best yield with the minimum of errors and/or expenditures.	98.3
Technical functionality - if it fulfills its purposes: assistance in data collection and automation in the transfer of these to CGI software.	96.0
Content quality - concepts, information, references, images, etc. used in the tool (reinforce key points and significant ideas).	75.6
Utility - a perception that the use of the tool is valid.	69.0
Coherence - logic, meaning between the contents, the objectives, the activities developed, the evaluation and the profile of the student.	68.5

Regarding the five attributes selected as the most relevant of the tool, three of them belong to the group of attributes related to the design of the tool (first, second, and fourth), and two belong to the group related to the pedagogical part (third and fifth). There is a reasonable distribution of attributes by group, although the two best-ranked attributes have obtained a slightly higher average than the others, which leads to a slightly greater perception of relevance to the design elements of the tool, to the detriment of pedagogical attributes.

In addition, by analyzing the attributes perceived as strong, it will be possible further analyze to work on the attributes that received lower scores, without disregarding those indicated as most relevant to users.

The next graph (Figure 6.12) shows the values of the “total average of relevance” generated by **MaxDiff** calculations for each of the attributes.

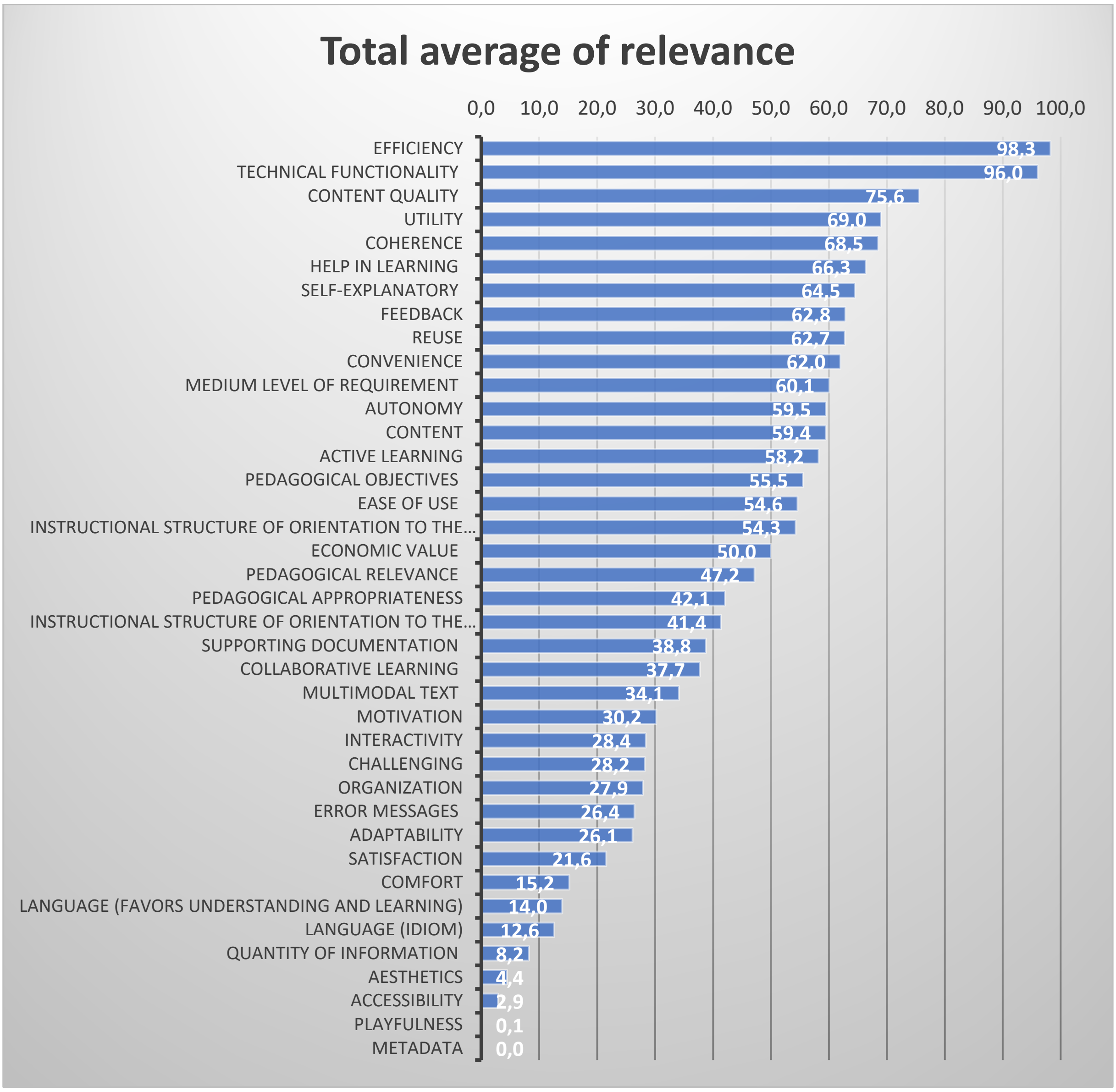

Figure 6.12 - Total average of relevance for each of the attributes

It is believed that each attribute should be analyzed individually, as some have a much more direct relationship with teachers who can use the tool, than with students. For example, an attribute such as metadata is very important and relevant for the deposit of the DLO in a repository of learning objects, so that it is more easily found. However, students do not normally have this type of understanding, so this attribute was ranked last, perhaps even due to this lack of understanding of the attribute or its purpose.

Two examples are the attribute “Instructional structure for teacher guidance”, which is less relevant for students, as well as the attribute with the lowest qualification of relevance “Metadata”. The latter, a technical element related to the platforms (repositories and references) of learning objects of which students may not even know the term or even its importance to help **DLO** for its indexing and ease of location on the internet, for example.

In this context, this assessment and classification of relevance allow us to understand the attributes that can undergo changes and improvements for the next improved version of the tool.

In addition, attributes as important, fundamental, and relevant as those that were considered the most relevant by the research participants (efficiency, technical functionality, content quality, usefulness, and coherence) indicate an initial and relative success of the prototype towards its objectives.

Statistical data regarding the relevance form

In this Form, in relation to statistical metrics, the mean value of the attributes was 42.7, the standard deviation was 25.4 and the adjustment, measured by the RLH (Root Likelihood) was 0.6962, considered to be good (this parameter varies between 0 and 1, the closer to 1, the better the adjustment - values above 0.6 are good). According to the calculations, the attributes to be valued were those that obtained in their total average of adequacy value above 68.1, that is, standard deviation (25.4) plus the average value of the attributes (42.7).

The average value of importance 42 (on a scale of 0-100) is due to the fact that there are attributes that are of little relevance to the respondents, and that, therefore, have results close to 0, which translates into a high standard deviation (also due to the number of subjects).

6.3. Form - Adequacy

The third form is an evaluation of the product's characteristics regarding its adequacy. This third form also used the methodology based on the Maximum Difference Scaling (**MaxDiff**) technique.

To create this Form of adequacy in the **MaxDiff** model, 16 attributes were selected among the 39 attributes created for the relevance Form, the ones that most appear in the various methods of evaluation of **DLO**s studied. These attributes were randomized by the **MaxDiff** survey application that was configurated to create 12 comparative questions with 4 attributes each question. Students had to mark in each of the 12 questions on the form, which of the 4 features were considered the most and least adequate. The 12 questions were randomly presented to each student participating in the survey to avoid bias related to fatigue if it had a single order for presenting the questions.

Although it was not possible to reach a larger number of subjects, which limits the analytical robustness, the research model presented good results.

Analysis of adequacy form data

All 12 attributes used in the questions on the adequacy form are shown in Table 4.1, on page 65, where they can be consulted. Such attributes are marked with the asterisk symbol (*) for identification and distinction between the attributes.

It was verified that the attributes selected as the ***most adequacy attributes*** of the tool were (Table 6.2):

Table 6.2 - Attributes with most adequacy of the DLO

Attributes	Total average adequacy
Technical functionality - if it fulfills its purposes: assistance in data collection and automation in the transfer of these to CGI software.	72.1
Pedagogical objectives - identifiable and appropriate to the target audience. Assistance in the practical activities of audiovisual production with real x virtual interaction.	61.4
Utility - a perception that the use of the tool is valid.	50.0
Help in learning - provided by the tool as an educational resource (learning object).	49.1

Analyzing these four attributes selected as the most suitable of the tool, it is possible to infer that there was a good distribution between the two groups of attributes taken into account during the creation of the tool. The first focused on the question of tool design and the second related to pedagogical issues and the creation of digital learning objects.

This distribution is noted in the four attributes, two attributes are belonging to each of the respective groups, besides, the groups alternate between their positions in the ranking of total adequacy averages. The first and third places are from the design attribute group, the second and fourth are from the pedagogical group. It should be added that the respondents did not know this subdivision between the attributes, only the research coordinator.

The next graph (Figure 6.13) shows the values of the “total adequacy average” generated by **MaxDiff** calculations for each of the attributes.

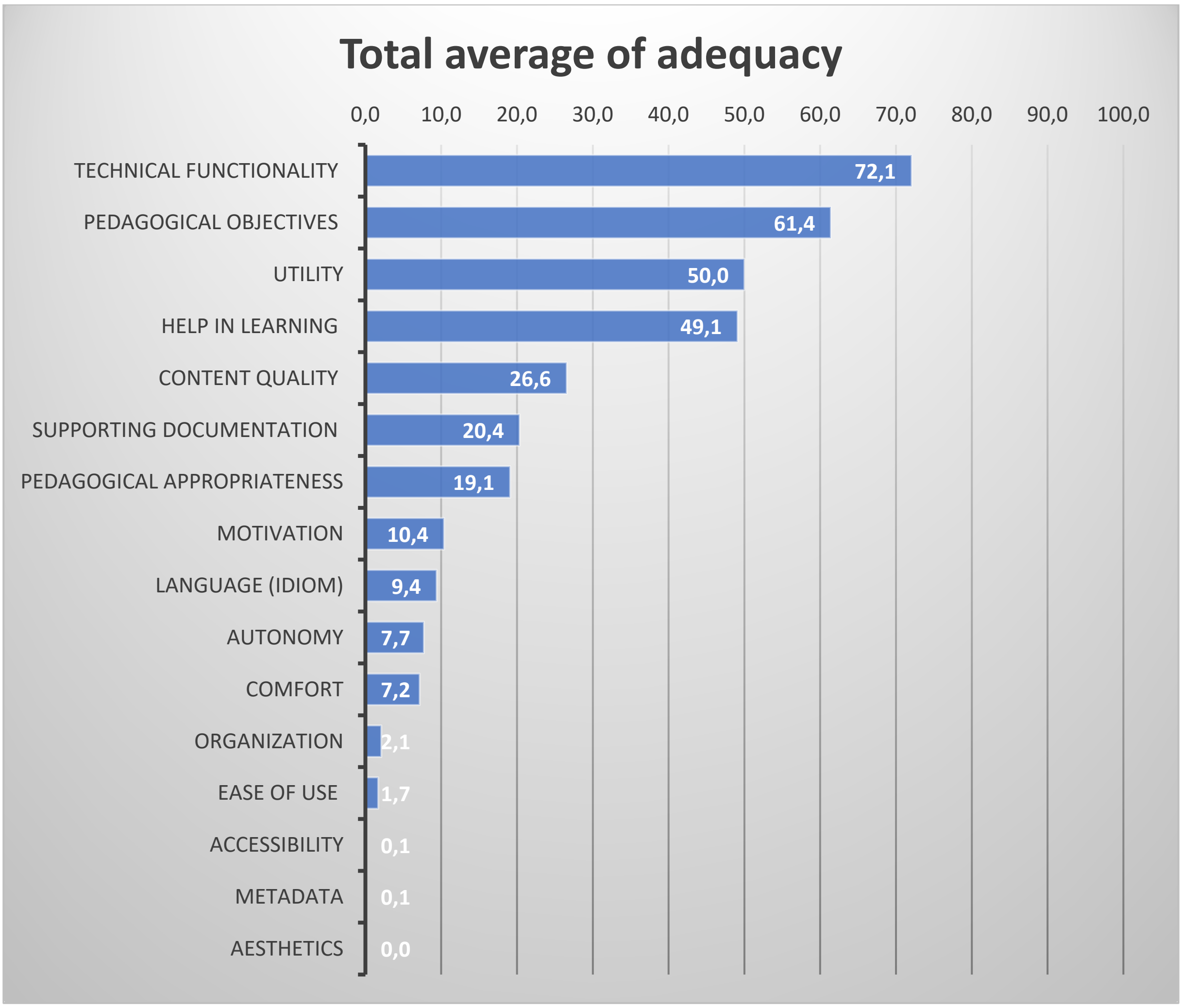

Figure 6.13 - Total average of adequacy for each of the attributes

Statistical data regarding the adequacy form

In this form, with respect to statistical metrics, the choice data were subsequently subject to estimation using a technique known as Hierarchical Bayes, with the respondents' choices being reapplied, via a logistic function, to a scale of 0-100 (for more details see Sawtooth (The MaxDiff System Technical Paper, 2013)). The mean value of the attributes' adequacy obtained was 21.1, the standard deviation was 23.9 and the adjustment, measured by RLH (Root Likelihood), was 0.7630, considered to be good (this parameter varies between 0 and 1, the closer to 1, the better the adjustment - values above 0.6 are good). According to the calculations, the attributes to be valued were those that obtained in their total average of adequacy value above 45.

The average value of importance 21 (on a scale of 0-100) is due to the fact that there are attributes that have aspects that are not very suitable for the respondents, and therefore have results close to 0, which translates into a high standard deviation (also due to the number of subjects).

6.4. Crossing between the data collected from the Relevance and Adequacy forms

Crossing the importance/relevance data (Form 02) with the adequacy (Form 03), it appears that the tool has adequacy below the relevance in the most important attributes, which means that it must be improved.

As the attributes of **MaxDiff** are, according to Sawtooth (2013), in a ratio scale, it is possible to make comparisons between them, without incurring scale problems.

That is, it is possible to take the value of the attribute from the relevance table and divide it by the value of the same attribute in the adequacy table, thus being able to assess how much one attribute is superior to the other.

As an example, the attribute “Technical Functionality” is 1.36 times more relevant than the appropriate one.

With these crosses, dividing the value attributed as "total average of relevance" by the value attributed as "total average of adequacy", it was possible to verify, therefore, which attributes presented adequacy below relevance in the attributes listed as the most important.

As a cutoff criterion, the percentage could be used, defining, for example, that any difference greater than 30% would be considered relevant, however, using the criterion of “statistically significant differences” raises the methodological requirement of crossing the data. This evaluation was made using repeated-measures ANOVA using the two conditions, which can be seen in the appendices starting on page 320.

In order to better exemplify, the attribute “Help in learning” which reached the ratio of 1.35 if it were considered through the 30% percentage cut, would be considered relevant, however when using the “statistically significant differences”, it was not considered with a statistically difference significant, even though it is a value very close to the attribute “Technical functionality” which reached the ratio of 1.36.

As a result, it is possible to infer that the attributes "Technical functionality", "Utility" and "Quality of content" have statistically significant value for greater relevance than adequacy.

Finally, although the adequacy analysis has shown relatively low values, there are many aspects that can be improved from the relevance analysis. Effectively, improving aspects with values above 60, for example, it may be possible to create an even better version of the tool than the current one.

6.5. Experimental research - Blind analysis

This last experimental analysis was designed because there was no prediction whether the tool created would contribute only to the understanding of the theoretical, technical and technological concepts involved and assist in the complex task of collecting data during filming (for the production of visual effects), or whether it could also somehow generate some significant gain in quality or productivity in the audiovisual material to be produced.

This quality gain was inferred based on one of the characteristics of the tool, of automating part of the task of building/creating virtual elements, based on their respective real counterparts, in the three-dimensional universe of specific computer graphics software.

That is, this automation functionality by reducing the time necessary for the execution of the referred visual effects offers the user:

a) the ability to develop the exercises with the same quality but in less time? (productivity gain).
b) with more time available, present a result of higher quality (due to being able to further improve the product to be developed in the same period of time).

To address this question, in addition to the three forms used with the participants of this research, practical audiovisual work was developed during the mini-course where students/participants could put into practice the concepts seen during classes. After completing these exercises, which generated a final audiovisual product for each participant, these works were sent to three professionals for blind evaluation.

Any information was removed from the digital video files generated by the participants that could identify them so that it was possible to assess whether there would be any type of influence of the tool (learning object) on the results of the work.

The evaluators (2 university professors in the audiovisual area and 1 professional from the market not working in the academy) assigned two marks for each work. Each of the audiovisual works was composed of two scenes that contained different real x virtual interactions. Thus, each of the notes referred to each of these interactions.

The evaluators used as parameters for judgment, the verisimilitude of the interaction in general, judging elements such as shadows, lighting (color temperature, type of light, luminous power), as well as the positioning of the lights, the animation, the movements used, the quality of the masks used for clipping, and the chroma-key execution. In addition, they were alerted to their own more abstract and subjective perception as a spectator, as elements such as a soundtrack, sound effects, how the audiovisual product was assembled, also influence the perception of verisimilitude of the video due to the context in which it is inserted. Another important point to be considered would be the level of quality of the integration between real and virtual images.

Due to the small number of participants, which implies a low statistical power, it was necessary to resort to an intra-subject experimental design, in which all participants went through both conditions: Performing tasks with the Tool and Without the Tool eg Anderson (2001).

For this, the class was divided by random draw into 4 groups. The final audiovisual work to be produced by the students would consist of two scenes in which in each of them a different real x virtual interaction technique/technology would be used. For the execution of these practical exercises, the execution time was divided in half, with the creation of two distinct moments (moment 01 and moment 02).

Thus, and in order to mitigate effects of order and prior learning in this type of experimental design (Anderson, 2001), (Shadish, Cook, & Campbell, 2002), each group would perform Scene A or Scene B in a different order (two groups starting with scene A and two groups starting with scene B), and in addition, each group would use or not the tool object of this research in one or another scene.

Below in Table 6.3, it is possible to see the subdivision of the classes and the use or not of the tool at each moment:

Table 6.3 - Subdivision of the groups and the use or not of the tool at each moment

	Moment 01	
Group 01	Scene A	With the tool
Group 02	Scene B	With the tool
Group 03	Scene A	Without the tool
Group 04	Scene B	Without the tool
	Moment 02	
Group 01	Scene B	Without the tool
Group 02	Scene A	Without the tool
Group 03	Scene B	With the tool
Group 04	Scene A	With the tool

For the execution of this research, many methodological issues led to greater attention and planning of the entire mini-course, so that it could offer the necessary methodological structure for a correct later evaluation of the data without problems that could compromise the data collection. Some of these methodological precautions were as follows:

- Use of a computer lab to perform activities in which all machines were identical in hardware and software configurations, to prevent certain students had any development advantage in the activities due to more robust configurations.
- Need to limit students' creativity to perform practical exercises. That is, all students had to develop the same exercises, using the same images captured as a basis. This requirement, although not allowing each participant to create their own story and audiovisual content for testing visual effects between real and virtual images, was important so that the work could be compared later, for a correct research of the qualitative differences between them. It is emphasized that different contents also bring with them different challenges and different degrees of complexity, which would make it impossible to compare the works.
- The minimum requirements for the production of the exercises were the same, however, the participants were free if they wanted to perform or improve their interactions beyond what was required of everyone if they thought they had the conditions and time available to do so. In other words, the minimum requirement for performing interaction activities was the same for all groups.
- All research participants had the same time to perform the activities. That is, they had the same number of classes in each of the moments (01 and 02) so that the execution time of each scene between the four groups was equal.
- The classes were planned to be taught in the evening so that all students participating in the mini-course had at their disposal the period between the end of classes until the morning of the next day to perform virtual image rendering activities. For this type of activity that requires a lot of time, this option was considered so that the class time could be better used, not necessarily needing to use the class time for this activity, however, all students were free to make the renderings during classes also if would prefer.

Blind Analysis - Data Analysis

Despite the effort to create the ideal situation for the execution of practical exercises so that it was possible to carry out a blind analysis of the works developed by the students, the initial group of 20 students (divided into 4 groups with 5 students each) had six dropouts during the execution of the activities of the mini-course (carried out during the period of 4 weeks). Thus, 14 participants completed their participation in the mini-course in full, which, despite the use of an intra-subject measure, results in a low statistical power (Anderson, 2001).

As noted initially, right after the collection of the values (grades) attributed to the practical work by the three evaluators, there were no differences it was found between the use and non-use of the tool in the quality of the work developed. Statistical calculations using repeated measures ANOVA were made, which can be checked through the appendices starting on page 325. However, there was no significant difference when compared to the simplified analysis that can be seen through Table 6.4 below which presents the average of the evaluations of the three evaluators and it is also possible to see the dropouts.

Table 6.4 - The arithmetic mean of the evaluations of the three evaluators for each exercise performed by the participants

			The average grade in the exercises	
	nº	**Subjects**	**Without Tool**	**With Tool**
Group 01	1	A	6,7	6,0
	2	Dropout		
	3	B	7,3	6,7
	4	Dropout		
	5	Dropout		
Group 02	6	C	7,7	6,7
	7	D	8,3	8,0
	8	E	7,3	6,0
	9	F	7,0	8,3
	10	G	7,0	6,0
Group 03	11	Dropout		
	12	Dropout		
	13	H	6,3	7,0
	14	I	7,5	7,0
	15	J	7,3	6,0
Group 04	16	K	6,2	7,0
	17	L	5,8	5,0
	18	M	6,3	7,7
	19	N	5,0	5,0
	20	Dropout		

Through the table and the graph (Figure 6.14) that follows, it is possible to visualize the non-significant difference between the situation of use or non-use in the result of the audiovisual products of each participant (practical exercises developed during the mini-course)

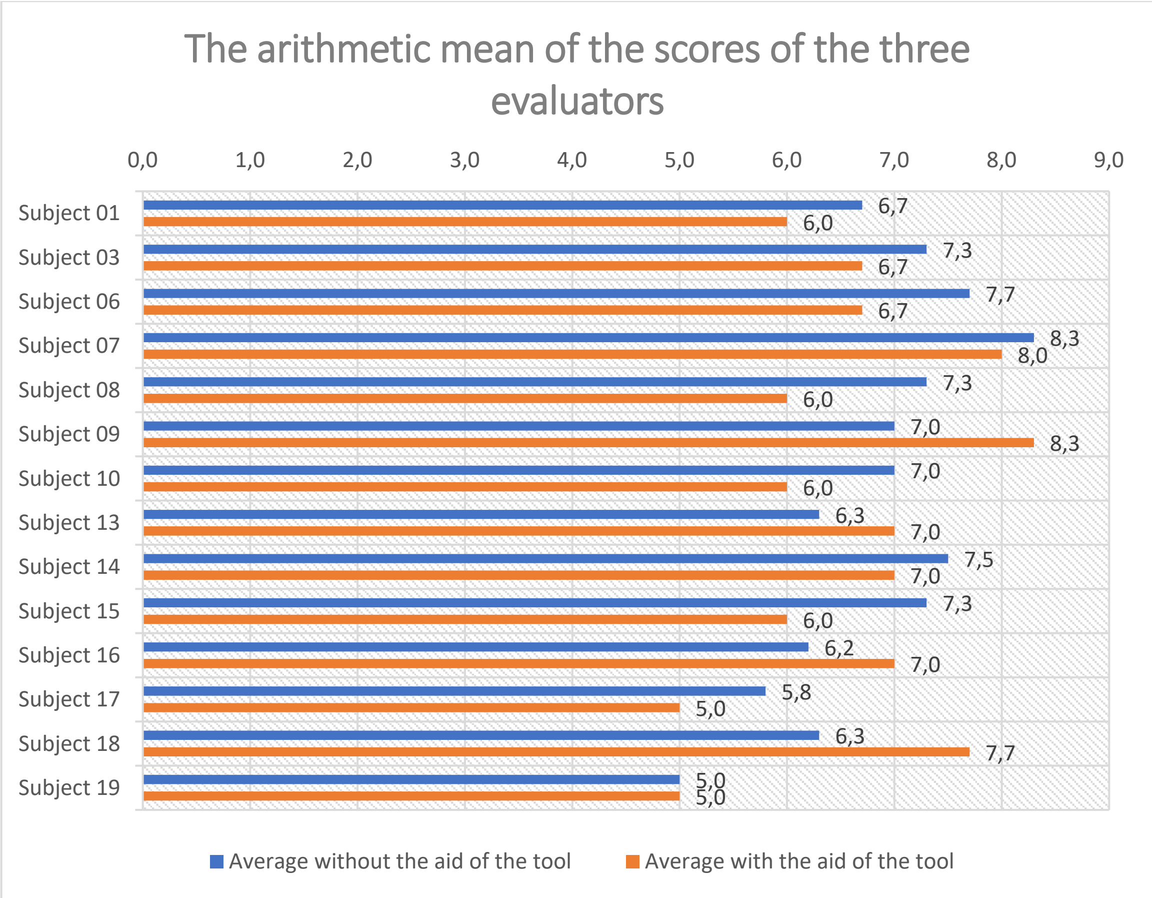

Figure 6.14 - Arithmetic mean of the evaluations of the three evaluators for each exercise performed by the participants

Despite the low statistical power already mentioned, and the fact that the tool has been positively evaluated in some of its aspects through research forms, there was no consequence of its use in the audiovisual product related to its use. At least in the controlled situation that was created, with equal structure and execution time between the participants, there was no qualitative difference with its use, clarifying that its contribution did not extend to the final quality of the production, their contributions being restricted to items as the pedagogical aspects and the organization of the production.

After no qualitative difference was found, the quotes of the authors below were taken into consideration, to reflect on possible “flows of cause and effect”, “silenced aspects”, to present possible correlated elements and make “broader conclusions of the data discussed”.

> The categorization of data allows its description. However, even if the research is descriptive, it is necessary for the researcher to go beyond the mere description, seeking to add something to the existing questioning on the subject. For that, he will have to make an effort of abstraction, going beyond the data, trying possible explanations, configurations, and flows of cause and effect. (Gil, 2002, p. 134).

> Another important point in this stage is the consideration of both the manifest content and the latent content of the material. Therefore, it is necessary that the analysis is not restricted to what is explicit in the material, but seeks to reveal implicit content, contradictory dimensions, and even silenced aspects (Lüdke, André, 1986). (Gil, 2002, p. 134).

> Interpretation. It is the intellectual activity that seeks to give a broader meaning to the answers, linking them to other knowledge. In general, interpretation means exposing the true meaning of the material presented, in relation to the proposed objectives and the theme. Clarifies not only the meaning of the material but also makes broader conclusions from the data discussed. (Marconi & Lakatos, 2003, p. 168).

For this, it is important also to use "observational techniques", described in the following quote.

> Observational techniques are empirical procedures of a sensory nature. Observation, while allowing the collection of data from situations, involves the observer's sensory perception, distinguishing itself, as a scientific practice, from the observation of daily routine. It can be said, for sure, that the planning and execution of fieldwork where the researcher interacts with the subjects of his research cannot disregard Observation as one of the techniques for collecting information, data, and evidence. In fact, in most studies of this nature, everything starts with careful observations about what is intended to be investigated. (Martins & Theóphilo, 2017, p. 84).

Our hypothesis is that the time gain that could have been used for any qualitative gain was not perceived perhaps for two main reasons.

The first reason - despite the repeated warnings, tips and instructions, many errors were noted in the collection of technical data for the execution of visual effects, perhaps due to the inexperience of students with the techniques and technologies employed, resulting in the need to spend time later for make corrections related to the data collected in an erroneous way.

The second reason - the vast majority of students when they perceived time savings due to the automation of the tool, they preferred to use that time to leave classes/activities earlier, instead of using that time to obtain an improvement in the execution of the tasks (activities). This could be justified by the simple fatigue and exhaustion due to a whole day of activities by a good part of the students (internship in the morning, undergraduate classes in the afternoon and the mini-course in the evening), as well the exhaustion due to the precarious climate situation in the laboratory used for the practices, something mentioned in item 5.2, on page 102.

In addition to these insights, it is important to note that all participants who took the course to the end, managed to perform both exercises and constitute the product, regardless of quality variation between jobs. The simple completion of the proposed exercises was considered very positive by both the teacher and the students.

However, observational techniques had not been formally planned at the beginning of the research, so it was not possible to establish elements of control and method of how to observe, as described in the quote below.

> The plan will delimit the phenomenon to be studied, indicate what should be observed, the ways to observe it, the duration, the periodicity, the way of records and controls to guarantee the validity and reliability of the material surveyed. (Martins & Theóphilo, 2017, p. 84).

In other words, no criteria were established, such as noting the time when each student participating in the research left the classes (how far in advance of the time limit for the end of activities).

In summary, if the option of using the observational technique had been planned in advance, it would be possible to assess in a more impartial way, with more accurate registration and control, for a real guarantee of the validity and reliability of the material surveyed and the interpretation of this material.

6.6. Research with teachers

The research with professors was something planned since the beginning of the research, however beforehand, there was no idea of the teachers' participation in the research. In this way, this research component has always been seen as a bonus to research, that is, if it were possible to really reach a satisfactory number of teaching participants it would be great to enrich the discussions and contribute to the analysis of the **DLO**. However, if the adherence rate were not representative, it would not cause damage to the work as a whole.

With this positioning, all the work was done in order to carry out this part of the research, either by creating a version of the forms with the questions adapted to the teachers or through a digital system for reading, signing and receiving the signed **ICF**, as well as through the availability of **DLO** through the PhD-related website (with instructional elements) or through international repositories.

As can be seen in the next graph (Figure 6.15), a total of 200 (two hundred) personalized e-mail messages were sent via direct mail to coordinators of undergraduate, technological and training courses in Brazil and Portugal, requesting the dissemination of the research to any professors working in subjects related to audiovisual, animation and computer graphics.

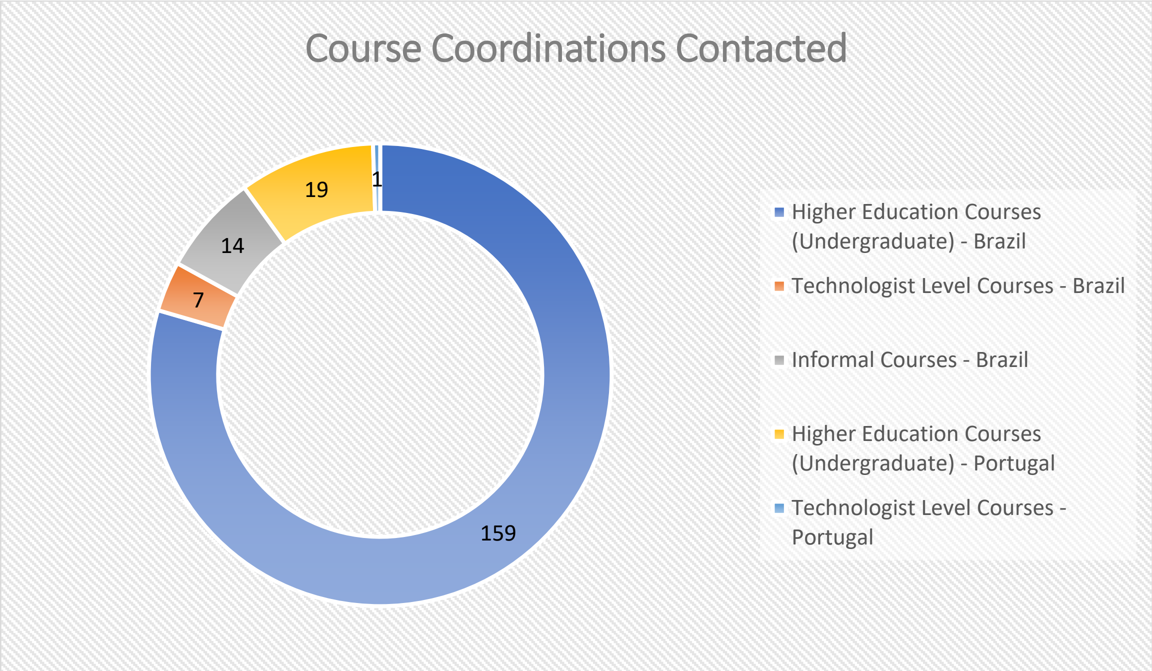

Figure 6.15 - Course coordinators contacted for research with teachers

The surprise of this researcher was, in the first place, the very low return by email of these contacts, communicating the receipt of the message, demonstrating support for the research, and willingness to forward it to peers (target audience). In the second place, it was the fact that although few contacts confirmed reception of the message, none participated in the research.

It is interesting to point out at this point the work of Janson and Janson, as it serves as a reference for this reflection, as they comment, for example “DLO integration inevitably creates challenges; teachers need to invest extra time and energy learning about and implementing DLOs (Wetterling and Collis 2003) and overcoming the technological challenges that come with any innovation (Freebody 2007)." (Janson & Janson, 2009, pp. 1-2). That is, there is a need not only for interest but for extra time and energy to learn and implement changes.

In addition, this lack of feed-back by these educational institutions further reinforces the following quote "By providing research that links students' use of DLOs with the development of key competencies, we hope to sharpen instructors' vision of how DLOs can help them achieve their educational goals and to encourage DLO uptake among teachers." (Janson & Janson, 2009, p. 1).

In other words, the occurrence highlights the importance of work like this, so that other teachers can realize the advantage of incorporating these new technologies in their teaching methods and practices.

> DLOs can be designed to help educators overcome their initial resistance to innovation uptake and understand the powerful teaching potential technology-rich learning environments represent. School principals wishing to build collective capacity and develop staff members are already experimenting with the unique e-learning models facilitated by DLOs. In this way, early adopters of educational technology can display leadership in facilitating transformational e-learning experiences for their peers. (Janson & Janson, 2009, p. 5).

6.7. Summary of results

An application DLO has been created to make it easy to annotate relevant and essential data for the execution of visual effects (**VFX**). In addition to providing fields for data collection, the application also provides some explanations of certain technical terms and links to external websites for a better understanding of certain concepts or to help in unit conversion calculations.

After using the application at the filming location, it makes available by email all the data collected in a completed form and forwards through a second email a script file created automatically by the application for use in **CGI** software. The script enables automating the task of reconstructing the data captured, directly in the **CGI** software.

For the creation of the prototype, several theoretical references were used to assist in its conception, concerning fundamental design components, covering concepts such as user experience evaluation design, instructional design, having as reference theoretical works such as (Vermeeren, et al., 2010), (Buxton, 2007), (Wiley D. A., 2000), (Piskurich, 2015), (Greenberg, Carpendale, Marquardt, & Buxton, 2012), (Adão & Jacob, 2011), and that relating to specific pedagogical components for the design of **DLO**s through works such as (Neto, Biagiotti, Baldessar, & Siqueira, 2017), (Braga, 2014), (Tarouco, Ávila, Santos, Bez, & Costa, 2014) and others.

After initial conceptual research, technical research and testing, prototype construction, testing and completion, field research began with 20 students and was completed with 14 students who effectively participated in a 60-hour course with 5 weekly meetings during 4 weeks, where they were subdivided into 4 groups. They performed 2 practical exercises that were divided into 2 different moments wherein each moment and exercise each group used or not the **DLO** to assist in the execution of the tasks.

At the end of the 2 practical exercises during the course, students answered 3 forms so that they could evaluate the **DLO** in three dimensions: 1) product concept analysis, assessed primarily on a linear scale from zero to ten points by respondents (Likert Scale or Decis) (Martins & Theóphilo, 2017); 2) evaluation of the product characteristics regarding its relevance, which used the question format called Maximum Difference Scale (Sawtooth Software, Inc., 2013) where it is possible to make a ranking of attributes to know which are considered the most and least important; 3) evaluation of product characteristics regarding its suitability, also used the **MaxDiff** question format.

Several methodological precautions were taken, such as the manipulation of an independent variable, forms of control and observation of effects, and random distribution. Previous research that served as the basis for this organization and methodological care for the development research part for consequent statistical and ethical validity were (Goodwin, 2010), (Coolican, 2009), (Hair, Anderson, Tatham, & Black, 2010), (Singh, 2006).

A blind analysis was also performed using the products developed by the students during the course to infer qualitative gain in the work (due to possible time savings generated by the tool automation function). However, it was noted that students, instead of using the possible time gained for qualitative improvement of their work, preferred to close their daily activities earlier.

In the end, it was found that the DLO tool was very well evaluated both conceptually, and in the relevance and adequacy analysis ranked relevant criteria/characteristics as most important. It was considered relevant, differentiated, with credibility and high intention to use (among other metrics). The blind analysis showed that there was no qualitative difference between the works developed with or without the aid of the tool.

It concludes by a positive indication of the use of DLOs in teaching practice in higher education because the digital tool, besides being very well received by students during classes, also aids in the review and reinforcement of the learning content.

Chapter 7 - CONCLUSIONS AND PERSPECTIVES FOR FUTURE RESEARCH

This last chapter seeks to present the conclusions of the research, highlighting the contributions, the impact on society, in addition to presenting recommendations, and the limitations encountered.

In addition, it prospects other possible research that may be forwarded in the future.

7.1. Conclusions

It is necessary to analyze whether the results achieved answer the research questions satisfactorily so that the research is reaching the objectives that it was proposed for. For this, the questions will be exposed again to facilitate the conclusions related to each one of them.

RQ1: Can Digital Learning Objects produce a sense of pedagogical gain in the teaching and learning process by students? Or are they just new media formats for transmitting the same content without necessarily bringing a difference to the understanding of the subject taught?

From the data presented and analyzed, although the respondents found the idea of having a tool of this nature very good, however, the version of the tool does not seem to be totally adequate. For this reason, the future idea of a new version that can already integrate the suggestions for improvement coming from the relevance indicators according to **MaxDiff**, is a relevant proposition so that it can more efficiently meet the educational goals.

However, it is possible to answer that the developed and tested **DLO** was able to positively produce pedagogical gain in the teaching and learning process on the part of the students since all reported positively when ranking attributes such as efficiency, technical functionality, pedagogical objectives, quality of the content, usefulness, consistency, and help in learning as the most relevant and appropriate indicators.

RQ2: What type of digital media support (ICTs / DLOs) could support teaching and practice in capturing data for the production of visual effects where there is integration between real and virtual images (match-moving)?

The theoretical and technical research led to the creation of an application based on digital forms.

Such a prototype containing several digital media resources embedded, such as images, external links, and videos. In addition to these, the automation feature developed that makes the tool not only an important checklist but also delivers computational resources for the automated generation of scripts for **CGI** Software 3ds Max®.

RQ3: Is the availability of **DLO** in repositories sufficient for its dissemination and possible use by teachers and students?

The research pointed out in its bibliographic review that availability in the repositories is fundamental, but also attested to the importance of dissemination through a dedicated website. The actions taken with the developed prototype answered both questions, making it available so far in two international repositories in addition to being hosted on its own website for this Ph.D.

Regarding sufficiency, it can be concluded that, for its dissemination, it is sufficient so that it is located by all possible interested parties. However, to ensure the real use by teachers and students, this is not enough, since the use and incorporation of new technologies in education depend not only on the educator's personal perception and proactivity but also on all agents involved in the teaching process. This includes institutional programs of qualification and incentive to implement technologies in traditional educational environments.

RQ4: What is the pedagogical and technical validity of the proposed learning object for undergraduate students related to audiovisual production?

Considering the specific research questions, it is possible to establish that the developed **DLO** obtained positive pedagogical and technical validity, despite this perception being positively verified through surveys via forms, but it did not present direct results in the quality of the products created during classes, measured by blind analysis. This fact will be further explored later in this conclusion, through examples from other research that have also resulted in similar conclusions.

RQ5: What features of the tool can be improved for future versions?

The features of the tool that could be improved for the next future versions were also identified. For this, it is possible to invest in improving aspects that were rated above a certain value.

For the results of relevance, for example, it is possible to privilege attributes that reached a score above 90% (2), or above 70% (3). For the adequacy results, for example, attributes that reached a score above 70% (1), or above 60% (2) can be privileged.

The higher the percentage value for selecting the attributes to be chosen for improvement, the more these attributes were better evaluated, and the lesser number of attributes will be ranked. In contrast, the lower the percentage value for selecting attributes, the more attributes will be selected for improvement.

With this method, it may be possible to create an even better version of the tool than the current one.

RQ6: Is the use of the tool (DLO) capable of producing a qualitative gain to audiovisual products conceived through practical exercises in the pedagogical context?

Regarding the tool being able to produce qualitative gain to audiovisual products conceived through practical exercises performed in the classroom, the blind analysis did not reveal significant differences in quality between the control group and the test group. This reveals that it generates mostly greater motivation and involvement of the student in the learning process, or that in new research it would be interesting to use more methods of analysis to better interpret such results, as will be explained in the suggestions for future research.

In summary, the research presents contributions in the research of the real contributions of the **DLO** in the pedagogical activity. The data obtained allow us to infer that the prototype developed successfully achieved its main objectives (technical and pedagogical) and can also be used outside the educational context by professionals or students graduating from courses in the area. In other words, according to the students' perception, the tool was competent to assist in the practical activities of the topics that it covers.

The tool that was designed, tested and evaluated in the classroom, can be used free of charge by any teachers in the field by accessing it in the repositories of international learning objects in which it was deposited; in addition to having access to instructional information for its use in the classroom on the research website. Furthermore, research as a whole used free tools and is open, so it can serve as a reference for other teachers to develop their own **DLO**s.

It is also believed that the work reached a conclusion similar to that other works such as Popovich that points out:

> Educators can add this study to the growing body of research regarding the effectiveness of digital learning objects and other open education resources as effective learning supplements. (…) that digital learning objects can be employed to aid in student learning, (…) (Popovich J. J., 2018).

As with research carried out with medical students for the teaching of radiology, who concluded that:

> The blended learning method has a significant impact on performance during testing compared to the traditional method. The implementation of DLOs that complement face-to-face education makes it possible to strengthen the teaching process with high levels of satisfaction, justifying the time and resources required for their design and production. (Durán-Guerrero, Ulloa-Guerrero, & Salazar-Díaz, 2019).

Finally, the differences found in the comparison between the forms of concept, relevance, and adequacy (all positive) when compared with the results of the blind analysis (which showed no qualitative gain or decrease in the results) indicate the future recommendation of attention to the methods, for clearly demonstrate that the Hawthorne effect does not influence the results. Further exploration of collaborative studies to provide comparative results that go beyond case studies is also recommended.

The following is some research whose results are somehow useful to better understand the contributions and conclusions reached in this research. They show important results that dialogue in a certain way with those achieved in this research, for a more complete and comprehensive final reflection.

The research developed by Mehlhorn, Parrot, Mehlhorn, Burcham, Roberts, and Smartt (Use of Digital Learning Objects to Improve Student Problem Solving Skills, 2011) already presented in the literature review is interesting because it presented some results similar to those found in this Ph.D. research.

"The findings did indicate the majority of students viewed the DLO positively, and it can be a useful teaching tool." (Mehlhorn, et al., 2011, p. 6). In other words, the tested **DLO** was evaluated very positively as a useful teaching tool.

However, "One measure of effectiveness of any teaching tool is how it impacts student's performance on exams and assignments." (Mehlhorn, et al., 2011, p. 7) and when comparing the results between the students of the experimental group and the control group, there was no statistically significant difference between the results of the two groups.

In other words, despite the positive potential of the tool, its use did not alter the results of the exams, as in this doctoral work. The quote below illustrates very well what also happened in this current research.

> Overall, student perceptions of the DLO were positive, but they did not show improvements in overall student performance in the class for exams and assignments. As with most tools designed to increase student performance, there is no guarantee of success. In the end, it is still up to the individual student to work hard and be prepared for the class. Instructors can provide all the materials for students to succeed except the drive to be successful. (Mehlhorn, et al., 2011, pp. 8-9).

In this context, it is believed that the research developed during this doctorate corroborates Mehlhorn's statement below.

> It was assumed that student performance would be greater for all aspects of the DLO enhanced course as compared to the traditional course. Again, faculty cannot guarantee student success simply by developing better teaching materials. They can help with student outcomes, but the student is still responsible for putting in the necessary effort to be successful. (Mehlhorn, et al., 2011, p. 11).

It is also important to remember the recent work of Topal, Yildirim, and Önder (Use of Educational Films in Environmental Education as a Digital Learning Object, 2020), which sought to investigate the effects of educational films as **DLO** on the levels of knowledge and attitudes related to the environment of students, and the survey results also showed similar data.

Research has shown that:

> As a result of the study, there was no significant difference between the mean pre-test knowledge scores of the students in the experiment group who were given environment education with educational movies and those in the control group who were given environment education without educational movies ($p > .05$, $t = -.53$). Additionally, the knowledge test mean scores of the students after the implementation significantly differed between the groups in favor of the experiment group ($p < .05$, $t = -4.05$). (Topal, Yildirim, & Önder, 2020, p. 143).
>
> Another finding in this study was about the effects of educational movies on the attitudes of middle school students towards the environment. As a result of the analysis, no significant difference was found between the groups in terms of their mean pre-test attitude scores before the implementation ($p > .05$, $t = .515$). There was also no significant difference between the post-test mean scores ($p > .05$, $t = -.53$). (Topal, Yildirim, & Önder, 2020, p. 143).

However, it also showed through student feedback that:

> The students reported that educational movies were beneficial for their learning of the topic, contribute to better understanding of the course and the class that was held this way was more permanent. When the literature is reviewed, it may be seen that this result that was revealed by the views of the student was in agreement with those of several studies. Barnett, Wagner, Gatling, Anderson, Houle and Kafka (2006) reached the conclusion that popular movies were

> effective for students to make sense of scientific concepts and develop their mental structures. Likewise, several researchers reported that educational movies affected learning positively (Beuscher, Roebers, & Schneider, 2005; Birkök, 2008, Linebarger, Kosanic, Greenwood, & Sai Doku, 2004; Pekdağ & Le Marechal, 2007; Stoddard, 2009) and provided permanence for classes (Akbaş, Canoğlu, & Ceylan, 2015; Butler, Zaromb, Lyle, & Roediger, 2009; Sullivan-Kerber, Clemens, & Medina, 2004; Walker, 2006; Watts, 2007; Woelders, 2007). (Topal, Yildirim, & Önder, 2020, p. 144).

That is, although the results of the studies do not present significant differences between the pre-test and control and pre-test and post-test groups, students reported benefits for learning, attributing to **DLO** a better understanding of the course, corroborating for the defense of that positively affected the learning process.

Another research that also brings results close to those achieved with this doctoral research is that developed by Fonseca et al. (Impact of the Use of a Digital Learning Object in the Teaching of Clinical Assessment of Preterm Infants: A Comparative Study, 2012) which aimed to “to assess the cognitive learning of undergraduate nursing students on the clinical assessment of the preterm infants aided by the use of a digital learning object (DLO) linked to the Internet compared to the traditional classroom method.” (Fonseca, et al., 2012, p. 1192).

The interesting thing about the research is that in addition to having used a number of students very close to this Ph.D. research, it was also developed with students from a Brazilian public university and data analysis based on the results of statistical tests of pre and post-tests:

> There was no statistically significant difference between groups (p>0.05), however, it was documented, based on subjective assessment, a high level of satisfaction with the use of the educational technology and interest in the dissemination of the strategy to other themes and moments of the course. (Fonseca, et al., 2012, p. 1192).

The research carried out by López-Pérez et al. (Blended learning in higher education: Students' perceptions and their relation to outcomes, 2011), shows that since 2009 in Spain there has already been a trend towards the use of institutional virtual teaching alongside traditional teaching, in order to make **ICT**s improve and complement traditional teaching. The following quote also illustrates the strengths of using blended learning.

> According to our study, a high degree of utility, motivation and satisfaction is perceived from blended learning, which could lead students to have a positive attitude towards learning. Moreover, this conclusion indicates that blended learning reinforces students’ understanding of the subject in question, enhancing and supporting the learning process (Lei, 2010). (López-Pérez, Pérez-López, & Rodríguez-Ariza, 2011, p. 824).

In the same way, this research demonstrated that the **DLO** developed and used with the students was also perceived as useful, motivating, and positive in helping the learning process.

A database that correlates with these inferences, is the database available on the website "https://detaresearch.org" where there are indexed, comprehensive research bibliography of 355 research reports, summaries, and papers that document no significant differences (NSD) in student outcomes between alternate modes of education delivery.

It is believed that such studies converge with this research, positively signaling the implementation and defense of the contribution generated by **DLO**s in the learning process. These studies found that although results are not always noticed in the test scores and assessments to which study students are submitted, the students report that the incorporation of ICTs through DLOs helps in the teaching and learning process.

7.1.1.Contribution

By highlighting which characteristics and attributes were evaluated as the most important/relevant, it was possible to establish a ranking of more priority attributes to the **DLO** user. That is, it is possible to see more clearly which of these attributes (used in the most varied methods of **DLO**s assessment) are more relevant and should be prioritized during the design and assessment of **DLO**s.

In addition, the technique of crossing between the results of these forms, also allows a new way to better visualize which attributes are more suitable to receive improvements in new versions of the prototype. A new method, therefore, to better target improvements to be implemented in a **DLO**.

The blind analysis made from the materials produced with the aid of the tool, allowed the case study to contribute useful information for the scope of the literature regarding the use of **DLO**s in blended learning. That is, what are the real contributions of **DLO**s to learning.

The data obtained allow us to verify that the prototype developed successfully achieved its main objectives, as it fulfilled its technical purposes of assistance in data collection and in the automation task that transfers these to **CGI** software and may well be used outside the educational context. Also, it achieved its pedagogical objectives in helping in practical audiovisual production activities with real vs. virtual interaction.

The development of the research points out how the experience was enriching and valid in the pedagogical context. Besides, it can serve as a reference for other teachers to develop their own **DLO**s, having a theoretical and a case study as references.

The research contributed both the experience of creating a **DLO** that was designed and tested and evaluated in the classroom, as well as submitting the tool to two international repositories of digital learning objects, Merlot Repository (Brinthaupt, Pilati, & King, 2008) and OER COMMONS. – Open Educational Resources (Institute for the Study of Knowledge Management in Education - ISKME - supported by the William and Flora Hewlett Foundation, 2007), which after peer review have included the **DLO** in their respective catalogs and are now available for access by any individual.

The availability in repositories is an important feature in the definition and conceptualization of a **DLO** according to several researchers in the area (Prata & Nascimento, 2007), (Galafassi, Gluz, & Galafassi, 2013), (Braga, 2014), (Braga, 2015), (Tarouco, Fabre, & Tamusiunas, 2003), (Tarouco, Ávila, Santos, Bez, & Costa, 2014). The possibility of sharing allows it to be accessed and used by other teachers. Thus, the choice of the English language for the tool has allowed it to be disseminated to be used by a much larger number of international institutions.

Another pertinent and relevant contribution of this investigation refers to the workflow created during the development of the tool, which, through a didactic sequence, allowed to organize the entire class flow and the scene data notation technique itself for the production of visual effects.

Such organization of the working method provided greater enrichment during the learning and during the audiovisual production process, really helping in the task and avoiding the maximum of failures, avoiding rework and losses of time, effort and money to the users.

It should also be noted that in certain complex contents to be taught to beginning students, the understanding of the workflow can be considered a more relevant factor than the final result obtained during the proposed exercises.

In addition to all the contributions raised, it is important to note that during this doctorate, the Coronavirus Pandemic (COVID-19) occurred. In the course of events, the vast majority of educational institutions in the world had to readapt their teaching methods by adopting technologies, in order to be able to overcome the pedagogical challenges that the restrictions imposed on us.

Well, if previously discussions about distance learning, digital learning objects, blended learning were already relevant in the scientific scenario, due to these events it gained in proportion and dimension.

Therefore, these difficulties and challenges imposed on all of us teachers and students made the discussion about the real relevance, importance, and efficiency of these new technologies in teaching gain all the spotlights.

7.1.2.Impact on Society

Online learning tools, such as **DLO**s, allow students different ways to interactively acquire skills and content. In addition to reusable **DLO**s (especially if hosted in repositories), **DLO**s can be accessed at any time you need them, both while performing classroom tasks, with teacher support and guidance, and can review and reinforce the learning of the featured content.

It is also important to consider was it was not possible to find other **DLO**s designed to assist in teaching audiovisual visual effects production (**VFX**) for undergraduate education. This fact highlights part of the impact that the **DLO** created can aggregate the area in which it is included.

Besides, it did not meet either any software for personal computers or mobile applications with the properties and automated functions found in the developed application. In this way, the research also gives a valuable contribution and increases the resources available to aid in the production of **VFX** in audiovisual productions.

7.1.3.Recommendations

Instructors are encouraged to strategically incorporate digital learning objects into their courses to assist and reinforce classroom learning as well as to support the development of specific skills. Guidelines to ensure ease of access to the **DLO**, continuous user experience and timely feedback are to be observed and provide adequate support for rapid resolution of technical failures (especially in **DLO** prototypes under test and evaluation).

The differences found in the comparison between the concept, relevance and adequacy Forms (all positive) when compared with the blind analysis results (which did not show qualitative gain or decrease in the results), indicate the future recommendation of attention to the methods, to demonstrate clearly that the Hawthorne effect does not influence the results.

Moreover, **DLO** show to be a valid tool for students to learn in the digital environment. However, further exploration is needed to provide comparative studies that go beyond case studies.

7.1.4.Limitations

After conducting the field research, it was realized that other research methods could have been incorporated to improve the interpretation of some attitudes on the part of the students during the experiment, in order to know in more depth and propriety the real or potential time gain that the automation resource tool could provide.

It was noticed that many students preferred to eventually leave school earlier due to tiredness, heat, transportation, security, however, there was no systematization to collect this type of information. Such data could better explain if there really was a time that was not used qualitatively for the performance of activities in the classroom.

In addition to this methodological self-criticism, which will serve as a future proposition, the fact of working with a small number of participants also limited the analytical robustness of the research. That is, despite presenting appreciable results and numbers, if the universe of participating students were greater, the statistical power would also be so.

Within this context, the physical limitations encountered during the research are also found, which had to be performed in a computer laboratory that unfortunately had its air conditioning equipment in trouble and despite the various efforts undertaken long in advance, it was not possible to fix it in a timely manner. It is believed, as already explained, that such logistical limitation has also affected the students' commitment to take the mini-course, as well some of them in completing it.

7.2. Prospects for future research

The task of implementing the improvements of the tool, as well as the incorporation of new observation methods parallel to the methods employed in this research, already constitutes an opportunity to obtain more qualified results and a better tool.

In addition to this possibility, the foray into the production of new digital learning objects should also be considered. The individual or collective reflection on tools that can be useful in the disciplines that the present researcher teaches, or in other disciplines under the responsibility of other work partners can be a fruitful field for the design of new **DLO**s for the evolution and constant incorporation of **ICT**s in the modernization of the teaching and learning processes.

The experience lived during this research resulted in professional and personal growth, and besides bringing individual benefit, it inspired so that it can also generate motivation among other teachers, helping them through examples and assistance in the production and incorporation of the most diverse technologies such as tools to support learning.

In these next challenges, the constant improvement of **DLO**s production, evaluation, and validation methodologies may increasingly contribute to the academic discussions regarding the incorporation of digital media to the most diverse fields of activity.

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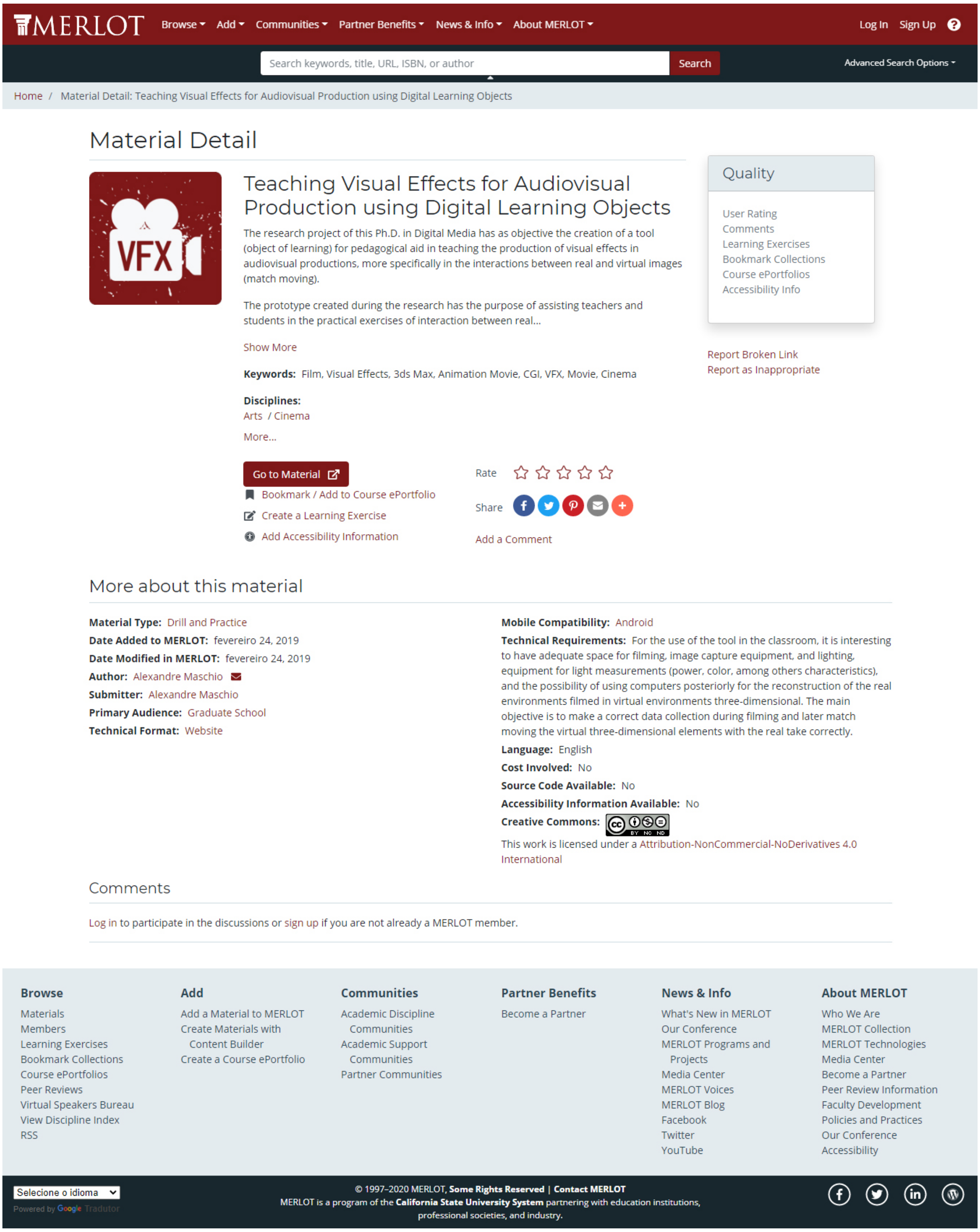
ANNEX(S) / APPENDIX(S)

Annex(s)

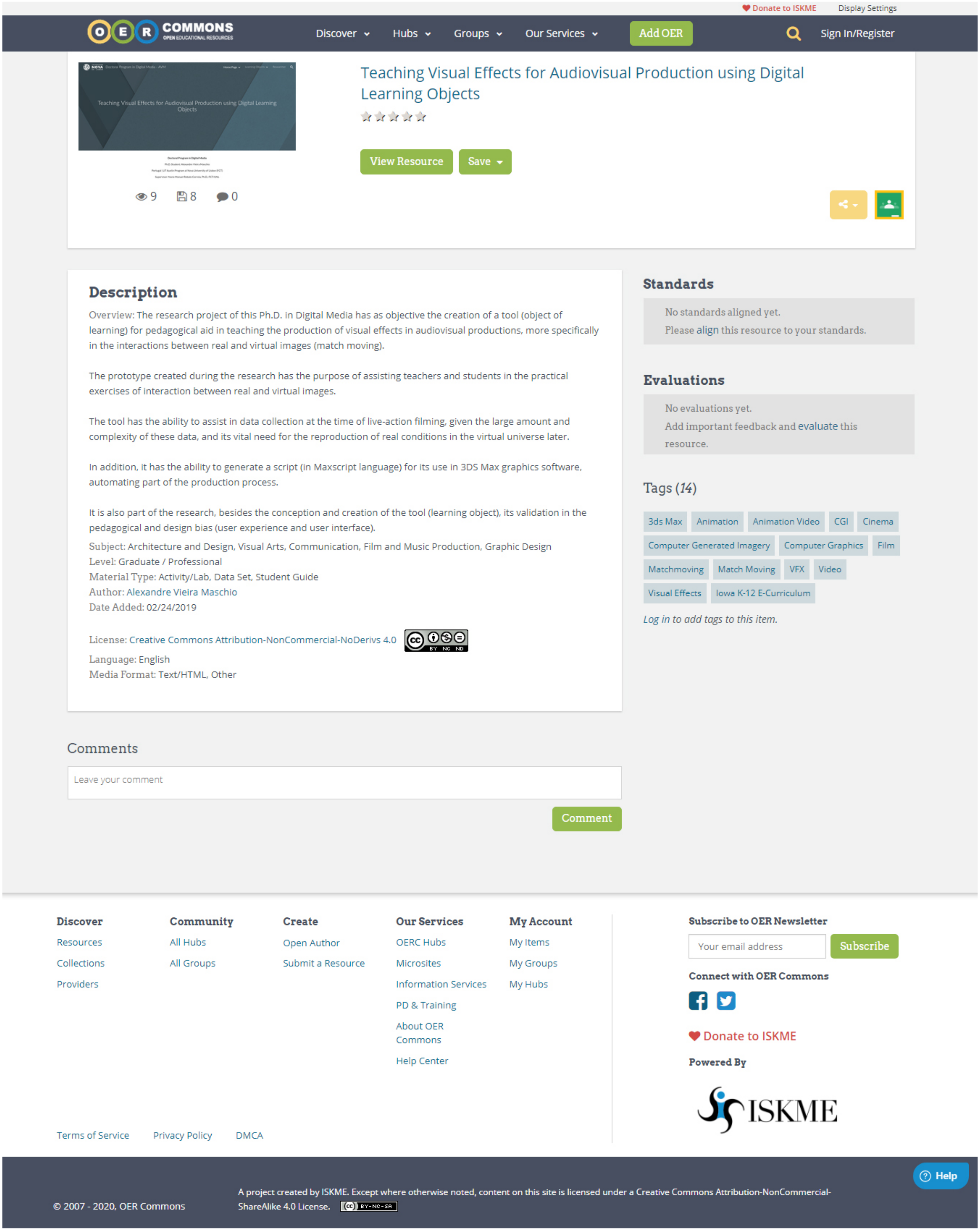
I. Availability of DLO in international learning object repositories (MERLOT)

MERLOT (MERLOT is a program of the California State University System partnering with education institutions, professional societies, and industry).



II. Availability of DLO in international learning object repositories (OER COMMONS)

OPEN EDUCATIONAL RESOURCES COMMONS & OPEN EDUCATION is a project created by ISKME (Supported in part by the William and Flora Hewlett Foundation, ISKME, the Institute for the Study of Knowledge Management in Education, created OER Commons as part of the Foundation's worldwide OER initiative).



Appendix(s)

I. Documents required to submit the project to the Ethics Committee, and description of the research team

In order to register and submit the research on the referred national digital platform, it was necessary, in addition to submitting the research project already approved by **CAT**, to create new documents and provide more methodological indications and formalities such as:

- Submission of a letter of consent from the institution (**UFPB** - Brasil) where the field research would be carried out (empirical part).
- Certificate of approval of the research project by the Postgraduate Program to which I am working and developing the doctoral research (**FCT | NOVA** - Portugal).
- Updated research execution schedule.
- Models of all forms to be used with all groups participating in the survey during the data collection.
- Form template for blind analysis by the evaluators who will evaluate the practical work developed during the short course.
- Model form for prior consultation of interest in participation in short course/research (preliminary consultation of interest in participation in short course/research).
- Term of Assent for use in the case of participants aged between 12 and 18 years.
- Informed Consent Form (**ICF**) to be completed and signed by all research participants in two copies, with one of the copies to be delivered to the participant.
- Cover sheet signed by the responsible researcher and by a person responsible for the proposing institution (**FCT | NOVA** - Portugal) who could not be the advisor this doctoral research, even he is also the doctoral coordinator.
- Discrimination from the research team, including:
    - The professor at **UFPB** and Research Coordinator **-** M.Sc. Alexandre Vieira Maschio.
    - The technical Server at **UFPB** – Mosar da Luz Nogueira Júnior (Brazil).
    - The Ph.D. in Experimental Psychology - Ricardo Gaspar Viegas (Portugal).
    - The Advisor **-** Prof. Ph.D. Nuno Manuel Robalo Correia (Portugal).
- Presentation of the financial budget for carrying out the research.
- Definition of inclusion and exclusion criteria, in addition to the definition of possible risks to participants and benefits to them, items that were not included in the initial research project approved by **CAT**.
- Research project approved by **CAT** original version in English.
- Research Project approved by **CAT** translated into Portuguese.

Discriminating the research team better:

The **UFPB** server Mosar da Luz Nogueira Júnior participated by assisting with the reservation of physical spaces within the building under the responsibility of the UFPB's Department of Digital Media (**DEMID**) da **UFPB**, in addition to assisting with the separation, assembly, and disassembly of equipment used during the exercises practical during the short course.

The **UFPB** server M.Sc. Ricardo Pinto Paiva also helped with the same activities and tasks, however, he cannot register with Platform Brazil so that his name was formally registered as a member of the team, however, let thanks be recorded to your person.

Dayse Araújo Gomes, a student in the Digital Media Communication course at **UFPB** , as an intern at **DEMID**'s computer labs, also helped with the installation of software and preparation of all the lab's computers to be used during the mini-course / research. Unfortunately, she was unable to register with Platform Brazil to officially appear as a member of the team, however, let thanks be recorded for her invaluable assistance.

The professor Ph.D. Nuno Manuel Robalo Correia, supervisor of this research project, as well as coordinator of the Doctoral Program in Digital Media at **FCT | NOVA**, responsible for making many of the necessary bureaucratic procedures feasible, was also registered with Platform Brazil to record his invaluable participation in the research.

The Ph.D. in Experimental Psychology Ricardo Gaspar Viegas[19], currently working in Lisbon at a leading global market research company, was also registered as a member of the research team, for working directly with methodology and statistics and being available to assist in the methodological part for the creation of the Research Form's and later in the necessary calculations for the statistical analysis of the results measured by them. An extract of your qualification is shown below, extracted from your own Curriculum Vitae, and here all thanks are due to your invaluable collaboration.

Areas of Expertise

Developmental Psychology, Microeconomics, Decision Making. Market studies and analysis of consumption profiles. The developmental approach to decision theories, especially decision analysis in adolescents, in a comparative perspective with adults (e.g., Theory of the Vague Trait / FuzzyTrace Theory). Prospect Theory, classic, and dual version (Hsee & Rottenstreich). Information Integration Theory and Functional Measure. Estimation of dispositional and attentional parameters using the Safety-Potential / Aspiration (SP / A) model. Somatic Marker Hypothesis and Risk-as-Feeling. Peripheral electrophysiology recording and analysis skills (GSR, ECG, Respiratory Response).

Methodology and Statistics

Research drawings and plans; Psychophysical Methodologies; Electrophysiological methods; Eye Tracking; Construction, validation, and analysis of scales and questionnaires. Joint analysis methodologies (Conjoint analysis, Conjoint choice analysis, MaxDiff). Descriptive statistics and advanced domain of inferential statistics: Univariate and Multivariate Analyzes (ANOVA, MANOVA, ANCOVA, ANOVA of Repeated Measures), Correlation and Regression Analysis (Simple, Multiple, Logistics, etc.); Classificatory Analysis (Cluster Analysis, Discriminant Analysis); Path Analysis and Structural Equation Models; Dimension Reduction (Principal Component Analysis, Confirmatory Factorial Analysis); Survival Analysis (Kaplan-Meier and Cox); Time Series Analysis.

19 ORCID ID: http://orcid.org/0000-0002-7816-4326

II. Negative Certificate - Issued by the Research Ethics Committee

UNIVERSIDADE FEDERAL DA PARAÍBA
CENTRO DE CIÊNCIAS DA SAÚDE
COMITÊ DE ÉTICA EM PESQUISA

C E R T I D Ã O

Certifico que o Comitê de Ética em Pesquisa do Centro de Ciências da Saúde da Universidade Federal da Paraíba – CEP/CCS/UFPB, aprovou por unanimidade na 7ª Reunião Ordinária, realizada no dia 26/08/2020, o parecer favorável do Relator desse egrégio Comitê, autorizando o pesquisador Alexandre Vieira Maschio, a publicar a Pesquisa intitulada: "ENSINANDO EFEITOS VISUAIS PARA PRODUÇÃO AUDIOVISUAL UTILIZANDO OBJETO DE APRENDIZAGEM DIGITAL". **CAAE: 03763418.6.0000.5188.**

João Pessoa, 04 de setembro de 2020

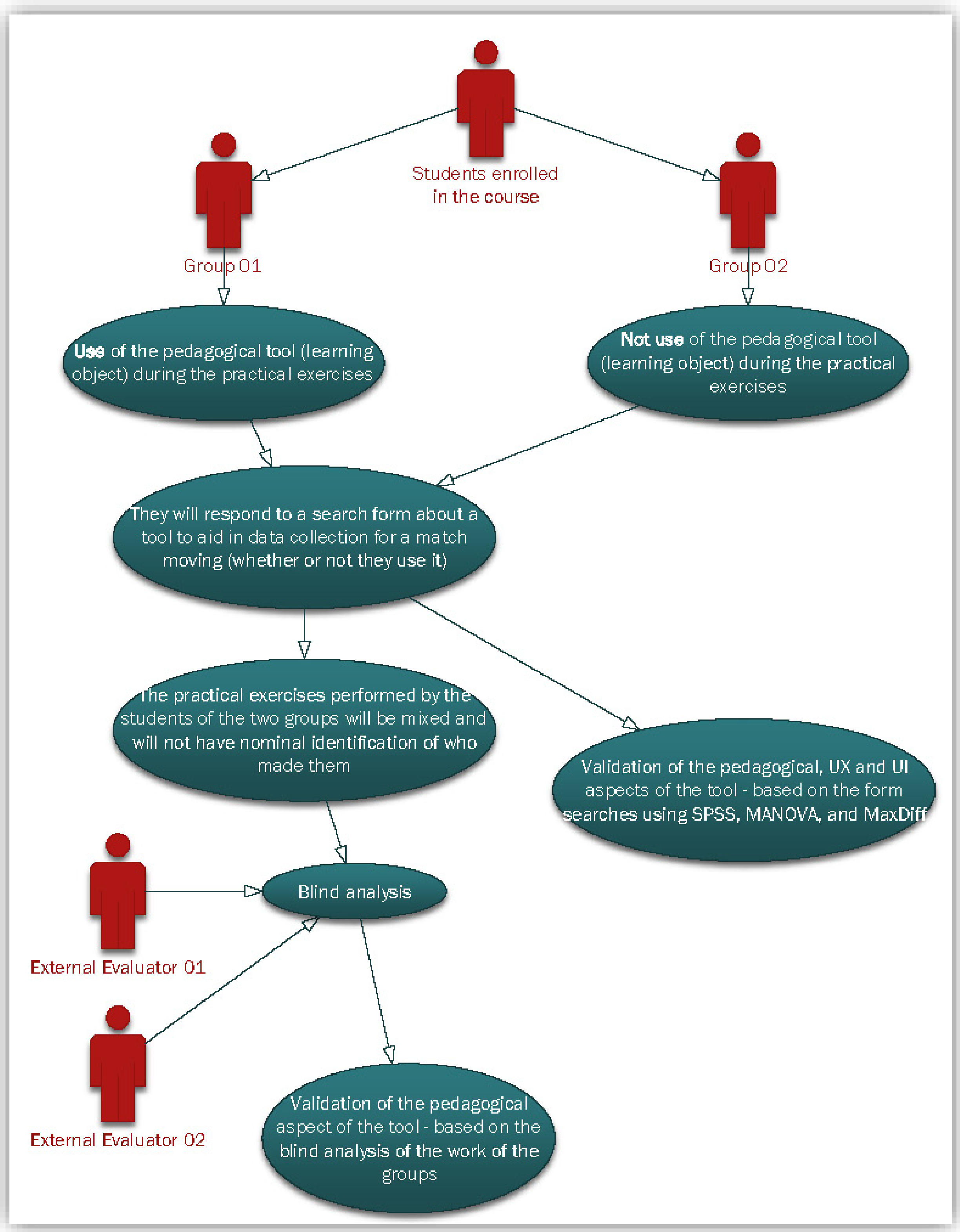
Eliane Marques Duarte de Sousa
Coordenadora CEP/CCS/UFPB
Matrícula Siape: 332618

Comitê de Ética em Pesquisa do Centro de Ciências da Saúde da Universidade Federal da Paraíba
Campus I – Cidade Universitária – 1º Andar CEP 58051-900 – João Pessoa/PB
☎ (83) 3216 7791 – E-mail: comitedeetica@ccs.ufpb.br

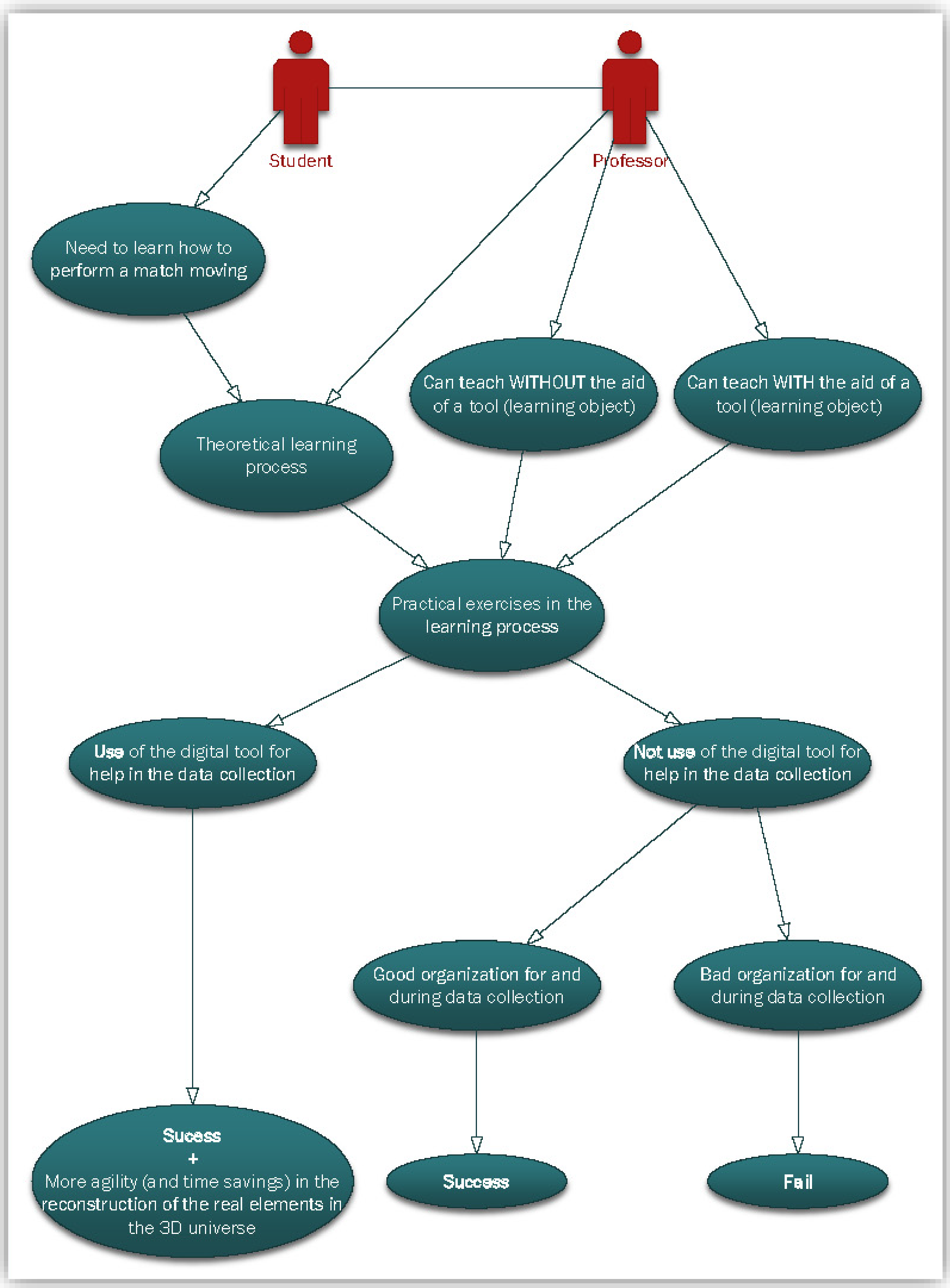
III. UML Diagrams

On the following pages, the four UML Diagrams produced to aid in the design of the prototype.

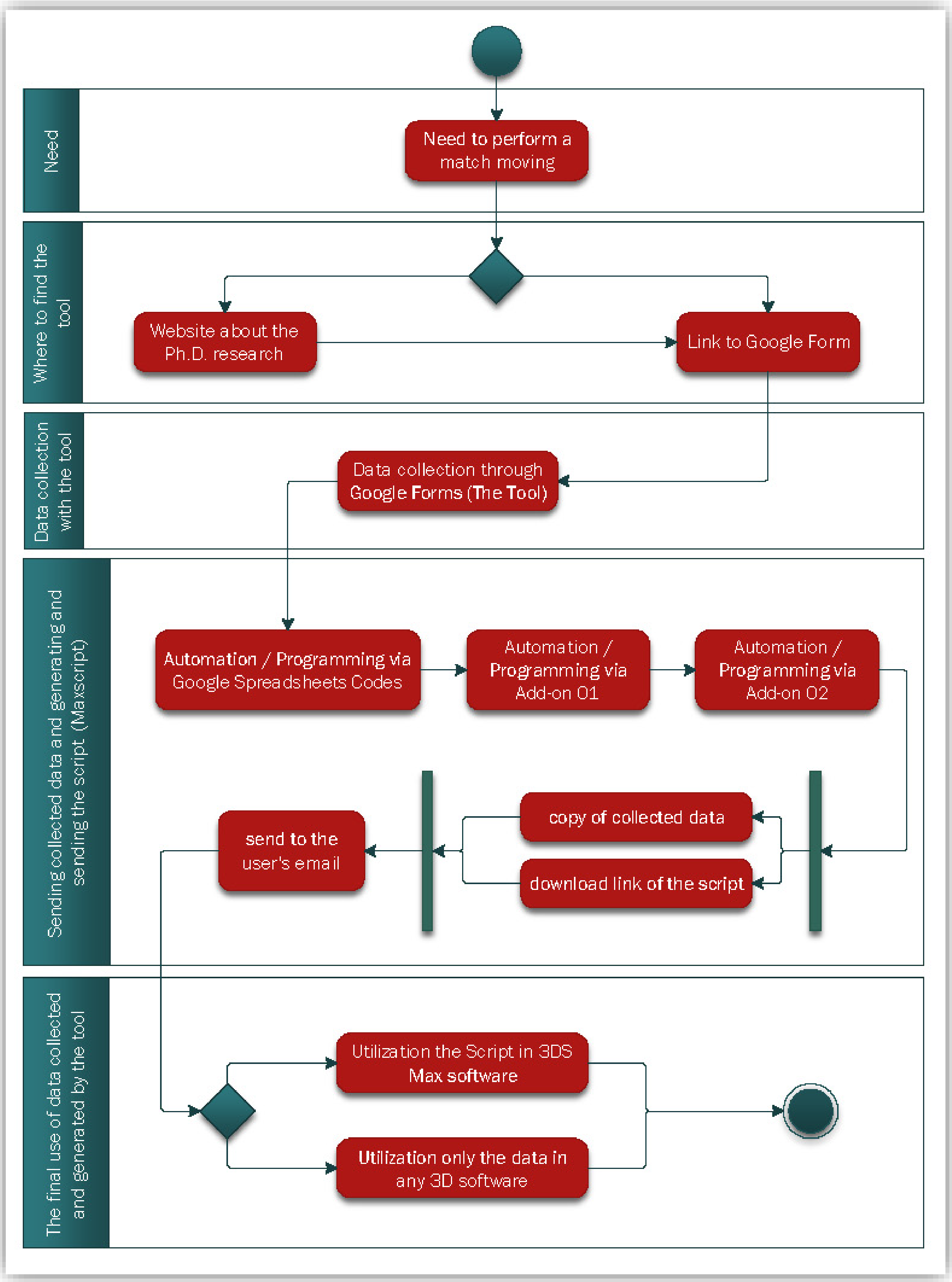
UML – Use Case Diagram - Methodology



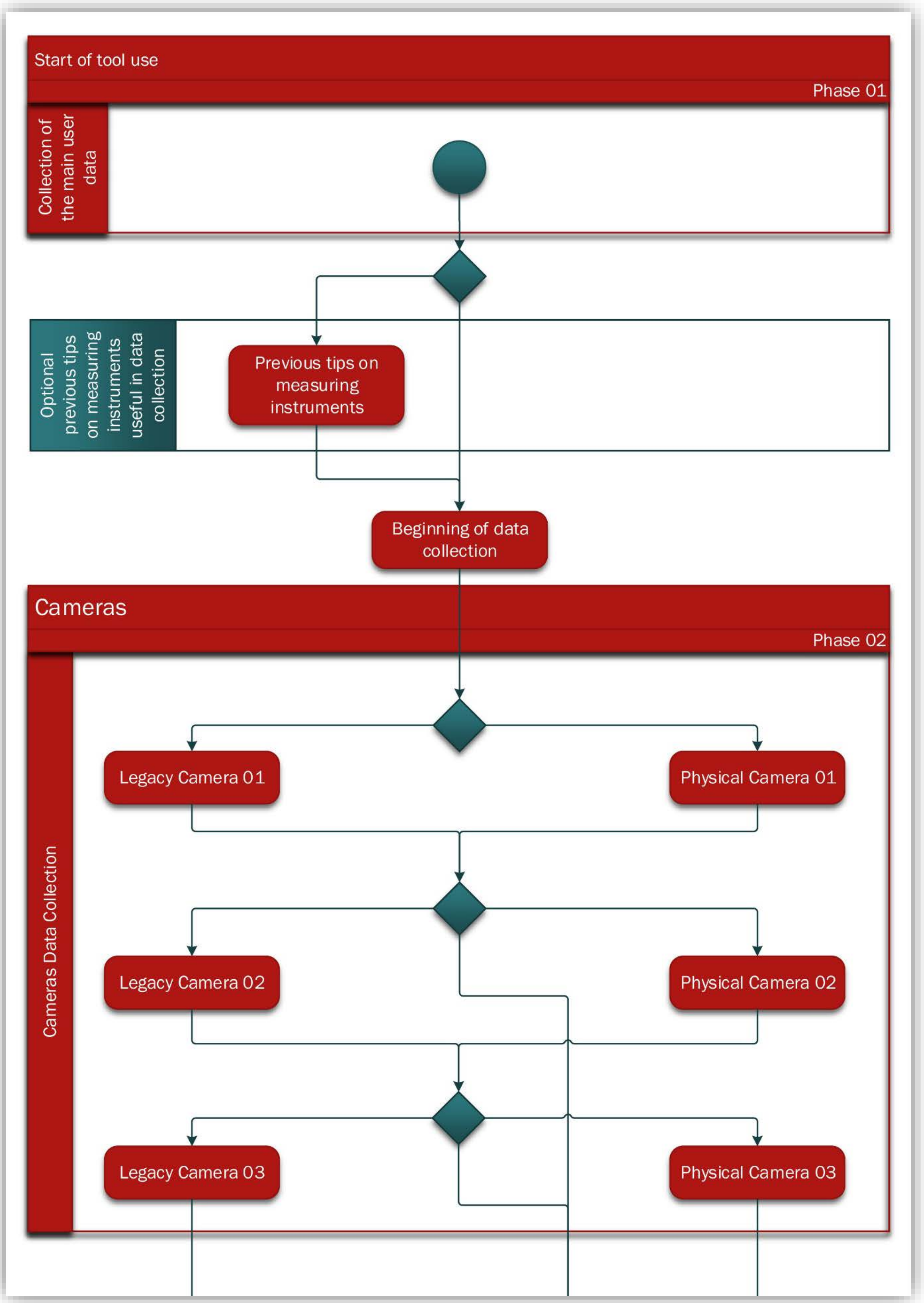
UML – Use Case Diagram – General problem



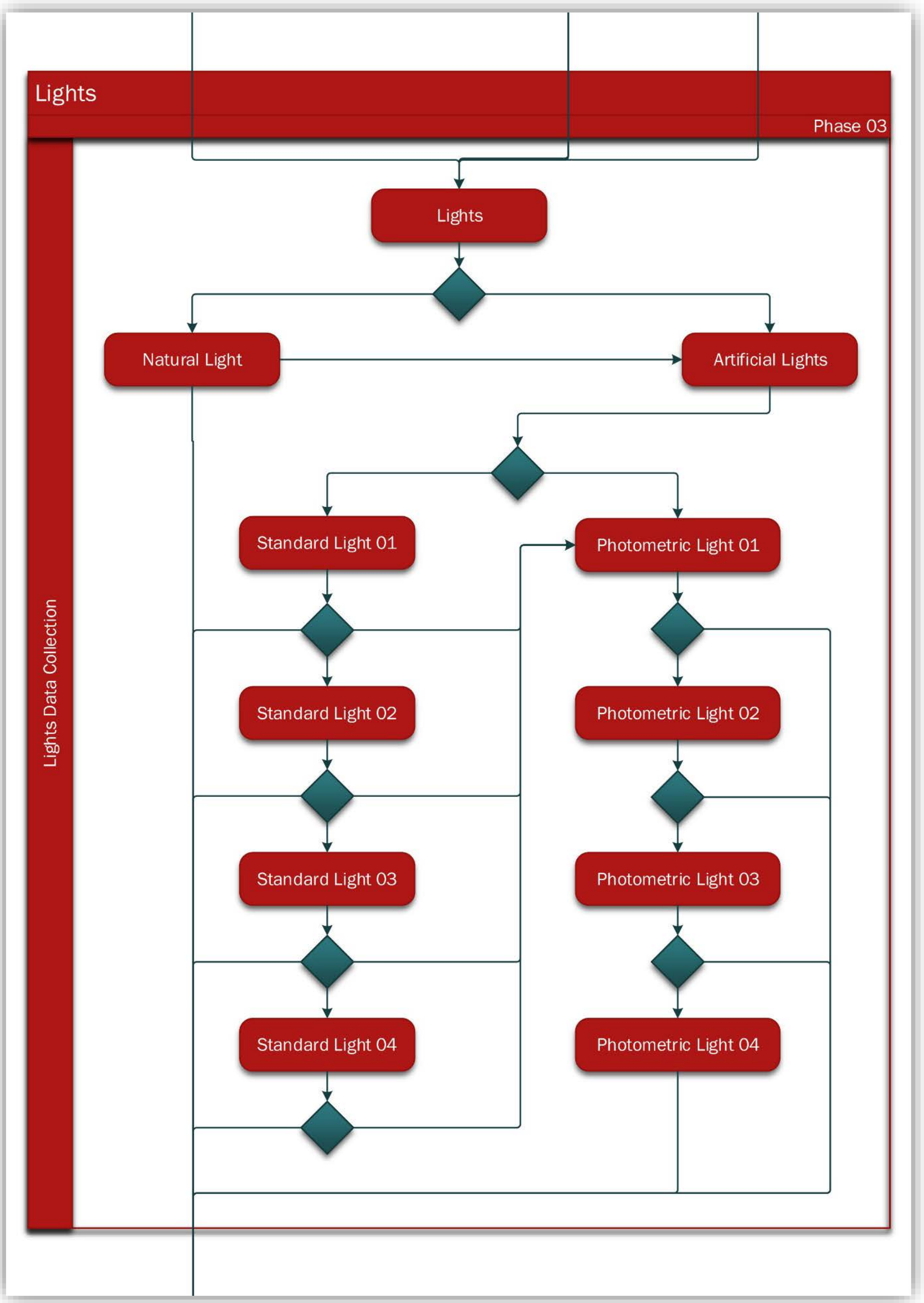
UML – Activity Diagram – General solution



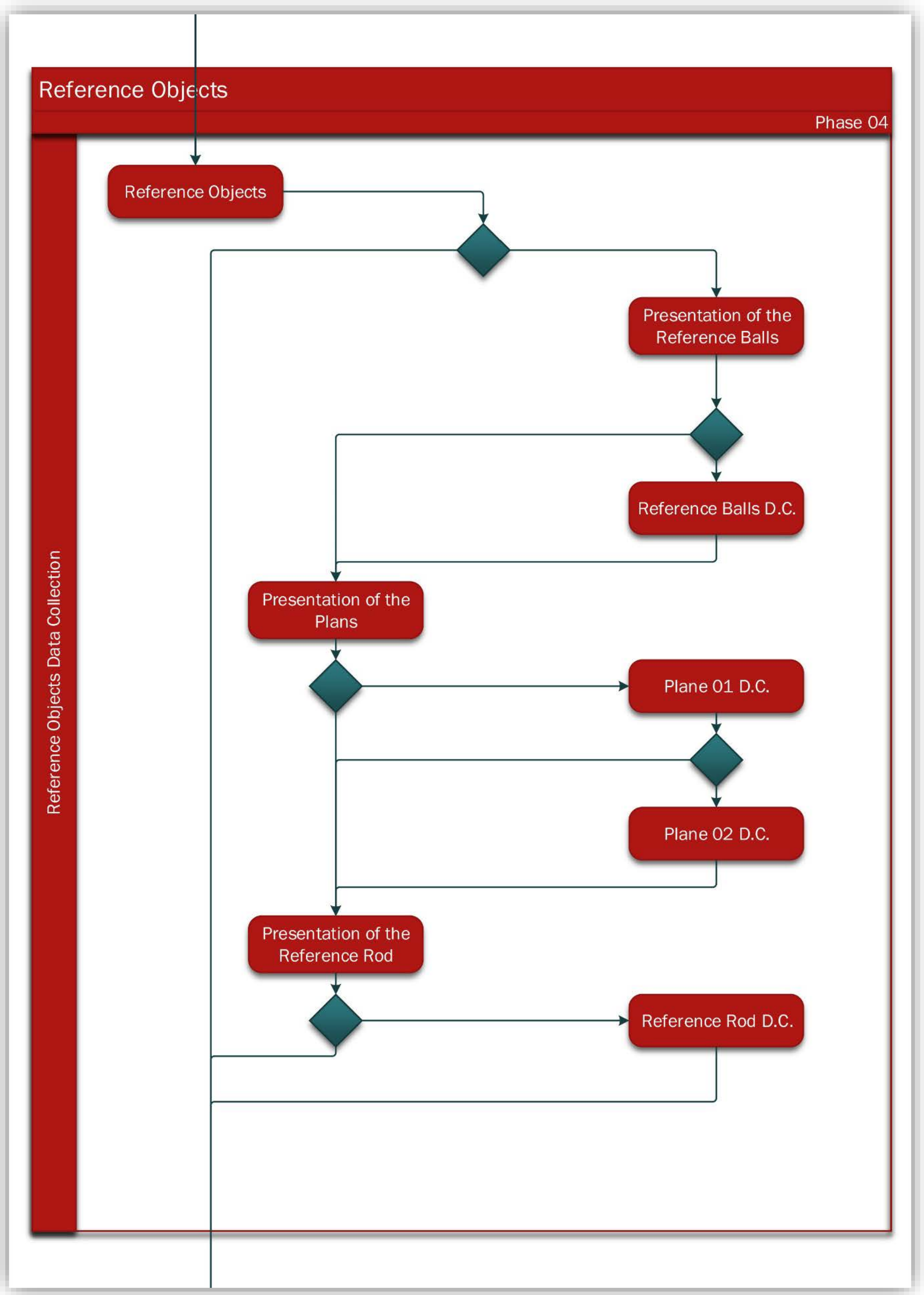
UML – Activity Diagram – Tool (Page 01 of 04)



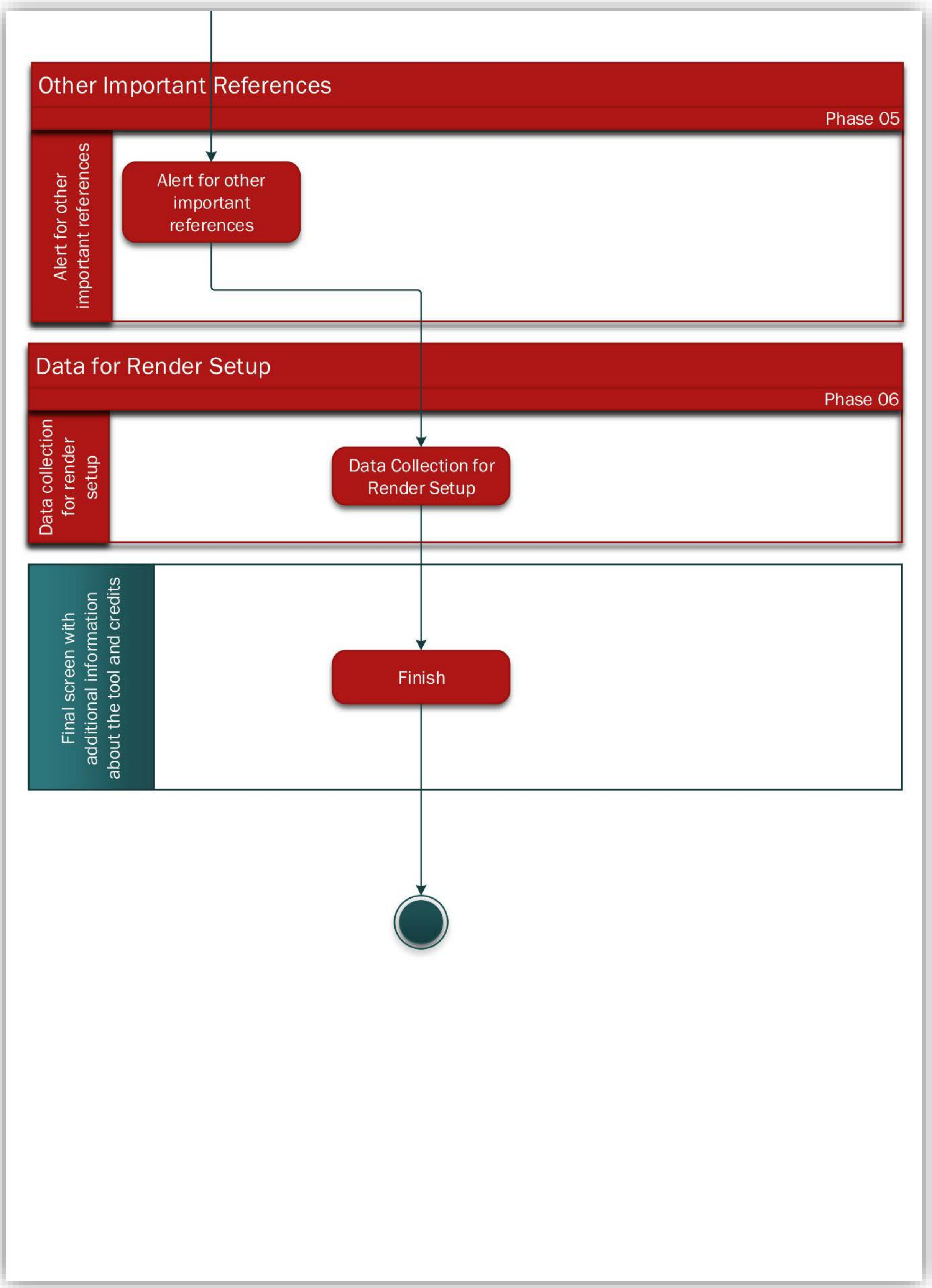
UML – Activity Diagram – Tool (Page 02 of 04)



UML – Activity Diagram – Tool (Page 03 of 04)



UML – Activity Diagram – Tool (Page 04 of 04)



IV. Spreadsheet formulas used

The spreadsheet formulas presented below are formatted (font, colors, spacing, etc.) as shown inside the spreadsheet when configuring it, in order to facilitate its understanding.

CAMERAS

The formula for legacy cameras - already incorporating whether the camera was used or not, whether it is target or free.

```
=SE(H2=0;"";SE(H2="Free Camera";CONCATENAR("Freecamera fov:";I2;"
targetDistance:";Z2;" clipManually:";J2;" nearclip:";K2;" farclip:";L2;"
showRanges:";M2;" nearrange:";N2;" farrange:";O2;" showCone:";P2;"
showHorizon:";Q2;" mpassEnabled:";R2;" mpassRenderPerPass:";S2;"
pos:[";T2;",";U2;",";V2;"]
isSelected:on";CARACT(10);"$.name=""";F2;"""";CARACT(10);"rotate $
(angleaxis 90 [1,0,0])";CARACT(10);"rotate $ (angleaxis ";W2;"
[1,0,0])";CARACT(10);"rotate $ (angleaxis ";X2;"
[0,1,0])";CARACT(10);"rotate $ (angleaxis ";Y2;" [0,0,1])";
CARACT(10));SE(H2="Target Camera";CONCATENAR("Freecamera fov:";I2;"
targetDistance:";Z2;" clipManually:";J2;" nearclip:";K2;" farclip:";L2;"
showRanges:";M2;" nearrange:";N2;" farrange:";O2;" showCone:";P2;"
showHorizon:";Q2;" mpassEnabled:";R2;" mpassRenderPerPass:";S2;"
pos:[";T2;",";U2;",";V2;"]
isSelected:on";CARACT(10);"$.name=""";F2;"""";CARACT(10);
"$'";F2;"'.type=#target";CARACT(10);"$'";F2;".Target'.pos=[";KK2;",";YY2;",
";ZZ2;"]";CARACT(10);"rotate $ (angleaxis ";X2;" [0,1,0])";CARACT(10);))))
```

The Formula for physical cameras - already incorporating whether the camera was used or not, whether it is target or free.

```
=SE(BB2=0;"";SE(BB2="off";CONCATENAR("Physical targeted:off ";WZ2;"
name:""";AB2;"""";" focal_length_mm:";AH2;" zoom_factor:";AJ2;"
f_number:";AI2;" use_dof:";AK2;" show_camera_cone:";XF2;"
motion_blur_enabled:";AL2;" target_distance:";BC2;" horizon_on:";AN2;"
";XC2;" environment_near:";AT2;" environment_far:";AU2;" clip_on:";AQ2;"
clip_near:";AR2;" clip_far:";AS2;" specify_focus:";XI2;"
focus_distance:";BE2;" pos:[";AV2;",";AW2;",";AX2;"]
isSelected:on";CARACT(10);"rotate $ (angleaxis 90
[1,0,0])";CARACT(10);"rotate $ (angleaxis ";AY2;"
[1,0,0])";CARACT(10);"rotate $ (angleaxis ";AZ2;"
[0,1,0])";CARACT(10);"rotate $ (angleaxis ";BA2;" [0,0,1])";
CARACT(10));SE(BB2="on"; CONCATENAR("Physical targeted:off ";WZ2;"
name:""";AB2;"""";" focal_length_mm:";AH2;" zoom_factor:";AJ2;"
f_number:";AI2;" use_dof:";AK2;" show_camera_cone:";XF2;"
motion_blur_enabled:";AL2;" target_distance:";BC2;" horizon_on:";AN2;"
";XC2;" environment_near:";AT2;" environment_far:";AU2;" clip_on:";AQ2;"
clip_near:";AR2;" clip_far:";AS2;" specify_focus:";XI2;"
focus_distance:";BE2;" pos:[";AV2;",";AW2;",";AX2;"]
isSelected:on";CARACT(10);
"$.targeted=on";CARACT(10);"$'";AB2;".Target'.pos=[";XX2;",";TT2;",";QQ2;"]
";CARACT(10);"rotate $ (angleaxis ";AZ2;" [0,1,0])"; CARACT(10);))))
```

The formula for preset selection (Physical Camera):

```
=SE(AD2="35mm - (Full Frame) - Width
36.0mm";CONCATENAR("exposure_value:";AF2;" film_preset:""35mm""
film_width_mm:36";" fov:";AG2);SE(AD2="APS-C (Canon) - Width
22.3mm";CONCATENAR("exposure_value:";AF2;" film_preset:""APS-C (Canon)""
film_width_mm:22.3";" fov:";AG2);SE(AD2="APS-C (Nikon, Sony, and so on) -
Width 23.7mm";CONCATENAR("exposure_value:";AF2;" film_preset:""APS-C
(Nikon)"" film_width_mm:23.7";" fov:";AG2);SE(AD2="APS-H (Canon) - Width
27.9mm";CONCATENAR("exposure_value:";AF2;" film_preset:""APS-H (Canon)""
film_width_mm:27.9";" fov:";AG2);SE(AD2="Four Thirds - Width
17.3mm";CONCATENAR("exposure_value:";AF2;" film_preset:""Four Thirds""
film_width_mm:17.3";" fov:";AG2);SE(AD2="Custom - Custom Width - input data
below";CONCATENAR("exposure_value:";AF2;" film_preset:""Custom""
film_width_mm:";AE2;" fov:";AG2);))))))
```

Being that:

AD2 -> place to be evaluated (where the answer in the table appears)

AF2 -> EV value in the table

AE2 -> film_width value in the table

AG2 -> FOV value in the table

The formula for selecting presets from White Balance (Physical Camera):

```
=SE(AO2="Daylight (6500K)";"white_balance_illuminant:0";SE(AO2="Sunlight
(5200K)";"white_balance_illuminant:1";SE(AO2="Shade
(7000K)";"white_balance_illuminant:2";SE(AO2="Overcast
(6000K)";"white_balance_illuminant:3";SE(AO2="Incandescent
(3200K)";"white_balance_illuminant:4";SE(AO2="Fluorescent
(4000K)";"white_balance_illuminant:5";SE(AO2="CIE A - Incandescent /
Tungsten";"white_balance_illuminant:6";"")))))))&SE(AO2="CIE D50 - Horizon
Light";"white_balance_illuminant:7";SE(AO2="CIE D55 - Morning/Afternoon
Daylight";"white_balance_illuminant:8";SE(AO2="CIE D65 - Noon
Daylight";"white_balance_illuminant:9";SE(AO2="CIE D75 - Northern
Daylight";"white_balance_illuminant:10";SE(AO2="CIE F1 - Fluorescent
Daylight";"white_balance_illuminant:11";SE(AO2="CIE F2 - Fluorescent Cool
White";"white_balance_illuminant:12";SE(AO2="CIE F3 - Fluorescent
White";"white_balance_illuminant:13";"")))))))&SE(AO2="CIE F4 - Fluorescent
Warm White";"white_balance_illuminant:14";SE(AO2="CIE F5 - Fluorescent
Daylight";"white_balance_illuminant:15";SE(AO2="CIE F6 - Fluorescent Light
White";"white_balance_illuminant:16";SE(AO2="CIE F7 - Fluorescent D65
Simulator";"white_balance_illuminant:17";SE(AO2="CIE F8 - Fluorescent D60
Simulator";"white_balance_illuminant:18";SE(AO2="CIE F9 - Fluorescent Cool
White Deluxe";"white_balance_illuminant:19";SE(AO2="CIE F10 - Fluorescent
TL-85";"white_balance_illuminant:20";"")))))))&SE(AO2="CIE F11 -
Fluorescent TL-84";"white_balance_illuminant:21";SE(AO2="CIE F12 -
Fluorescent TL-83";"white_balance_illuminant:22";SE(AO2="Halogen Warn
(2800K)";"white_balance_illuminant:23";SE(AO2="Halogen
(3200K)";"white_balance_illuminant:24";SE(AO2="Halogen Cool
(4000K)";"white_balance_illuminant:25";SE(AO2="HID Ceramic Metal Halide
Warm (3000K)";"white_balance_illuminant:26";SE(AO2="HID Ceramic Metal
Halide Cool (4200K)";"white_balance_illuminant:27";"")))))))&SE(AO2="HID
Quartz Metal Halide Warm (3200K)";"white_balance_illuminant:28";SE(AO2="HID
Quartz Metal Halide (4000K)";"white_balance_illuminant:29";SE(AO2="HID
Quartz Metal Halide Cool (6000K)";"white_balance_illuminant:30";SE(AO2="HID
```

```
Mercury (3900K)";"white_balance_illuminant:31";SE(AO2="HID Phosphor Mercury (4000K)";"white_balance_illuminant:32";SE(AO2="HID Xenon (6000K)";"white_balance_illuminant:33";SE(AO2="High Pressure Sodium (2100K)";"white_balance_illuminant:34";"")))))))&SE(AO2="Low Pressure Sodium (1800K)";"white_balance_illuminant:35";SE(AO2="I prefer to insert Kelvin measure below";CONCATENAR("white_balance_kelvin:";AP2);""))
```

Being that:

AO2 -> place to be evaluated (where the answer in the table appears)

AP2 -> Kelvin value in the table

Selection formula “show cone” (Physical Camera):

```
=SE(BY2="When Selected (default)";"0";SE(BY2="Always";"1";SE(BY2="Never";"2";)))
```

Selection formula “special focus” (Physical Camera):

```
=SE(CP2="Uses the Target Distance as the focus distance";"0";SE(CP2="Custom. Uses a focus distance other than the Target Distance";"1";))
```

LIGHTS

Natural light formula

```
=SE(IR2=0;"";SE(IR2="Yes, I want to collect natural light data.";CONCATENAR("theInt=DaylightSystemFactory2.Create sunClass:";IZ2;" skyClass:";JA2;CARACT(10);"$Daylight001.manual=0";CARACT(10);"max display mode";CARACT(10);"max motion mode";CARACT(10);"messageBox ";"""";"Attention ! \n \nThere is no way to enter the data related to natural light automatically through by Script. \nFor this reason, note down the data below because clicking on 'OK' will close this message (you can not see this message and enter the natural light data in the tab at the right side of the screen at the same time). \nAfter annotating the data, click 'OK' to close this warning screen for can insert the data. \nIf you do not want to write down, the data below is also on the copy of the completed form that was sent by e-mail. \n \nIf you have a weather file (Weather Data File - *.epw) you can select this option in 'Control Parameters' to select your file and then set the date and time. \n \nIn 'Motion' guide \nTime: \nHours/Mins./Secs.: ";(TO_TEXT(IS2));" \nMonth/Day/Year: ";(TO_TEXT(IT2));" \nTime Zone: ";IU2;" \nDaylight Saving Time: ";IV2;" \n \nLocation: \nLatitude: ";IW2;" \nLongitude: ";IX2;" \nNorth Direction: ";IY2;" \n \nIn 'Modify' guide \nFor 'mr_Sky' class for Sky (Models: Perez All-Weather and CIE) \nDiffuse Horizontal Illuminance: ";JB2;" \nDirect Normal Illuminance: ";JC2;" \n \nSky Coverage (for IES_Sky classes): ";JD2;" \nSky Coverage (for mr_Sky classes and CIE Sky Model): ";JE2;" \n \nYour Script was set successfully, good use! \n \nMaschio, A. V."; """";);SE(IR2="No, I want to collect data only from artificial lights.";CONCATENAR("messageBox ";"""";"Your Script was set successfully, good use! \n \nMaschio, A. V."; """";))))
```

The formula for standard lights – artificial

```
=SE(JH2=0;"";SE(JH2="Target Spotlight";CONCATENAR("targetSpot
name:""";JI2;"""";" rgb:(color ";JJ2;" ";JK2;" ";JL2;") multiplier:";JM2;"
castShadows:";JN2;" shadowMultiplier:";JO2;" lightAffectsShadow:";JP2;"
showCone:";JQ2;" coneShape:";JR2;" aspect:";JS2;" hotspot:";JT2;"
falloff:";JU2;" pos:[";JV2;",";JW2;",";JX2;"] isSelected:on
target:(Targetobject pos:[";JY2;",";JZ2;",";KA2;"])";CARACT(10);"select
$Target001";CARACT(10);"$.name=""";JI2;".Target""";CARACT(10));SE(JH2="Targ
et Directional Light";CONCATENAR("TargetDirectionallight
name:""";JI2;"""";" rgb:(color ";JJ2;" ";JK2;" ";JL2;") multiplier:";JM2;"
castShadows:";JN2;" shadowMultiplier:";JO2;" lightAffectsShadow:";JP2;"
showCone:";JQ2;" coneShape:";JR2;" aspect:";JS2;" hotspot:";JT2;"
falloff:";JU2;" pos:[";JV2;",";JW2;",";JX2;"] isSelected:on
target:(Targetobject pos:[";JY2;",";JZ2;",";KA2;"])";CARACT(10);"select
$Target001";CARACT(10);"$.name=""";JI2;".Target""";CARACT(10));SE(JH2="Free
Spotlight";CONCATENAR("freeSpot name:""";JI2;"""";" rgb:(color ";JJ2;"
";JK2;" ";JL2;") multiplier:";JM2;" castShadows:";JN2;"
shadowMultiplier:";JO2;" lightAffectsShadow:";JP2;" showCone:";JQ2;"
coneShape:";JR2;" aspect:";JS2;" hotspot:";JT2;" falloff:";JU2;"
pos:[";JV2;",";JW2;",";JX2;"] isSelected:on"; CARACT(10));SE(JH2="Free
Directional Light";CONCATENAR("Directionallight name:""";JI2;"""";"
rgb:(color ";JJ2;" ";JK2;" ";JL2;") multiplier:";JM2;" castShadows:";JN2;"
shadowMultiplier:";JO2;" lightAffectsShadow:";JP2;" showCone:";JQ2;"
coneShape:";JR2;" aspect:";JS2;" hotspot:";JT2;" falloff:";JU2;"
pos:[";JV2;",";JW2;",";JX2;"] isSelected:on";CARACT(10));SE(JH2="Omni
Light";CONCATENAR("Omnilight name:""";JI2;"""";" rgb:(color ";JJ2;" ";JK2;"
";JL2;") multiplier:";JM2;" castShadows:";JN2;" shadowMultiplier:";JO2;"
lightAffectsShadow:";JP2;" pos:[";JV2;",";JW2;",";JX2;"]
isSelected:on";CARACT(10));))))))
```

Each type of standard light

```
targetSpot name:"JI2" rgb:(color JJ2 JK2 JL2) multiplier:JM2 castShadows:JN2
shadowMultiplier:JO2 lightAffectsShadow:JP2 showCone:JQ2 coneShape:JR2 aspect:JS2
hotspot:JT2 falloff:JU2 pos:[JV2,JW2,JX2] isSelected:on target:(Targetobject
pos:[JY2,JZ2,KA2])

select $Target001

$.name="JI2.Target"

----

TargetDirectionallight name:"JI2" rgb:(color JJ2 JK2 JL2) multiplier:JM2
castShadows:JN2 shadowMultiplier:JO2 lightAffectsShadow:JP2 showCone:JQ2
coneShape:JR2 aspect:JS2 hotspot:JT2 falloff:JU2 pos:[JV2,JW2,JX2] isSelected:on
target:(Targetobject pos:[JY2,JZ2,KA2])

select $Target001

$.name = "JI2.Target"

---

freeSpot name:"JI2" rgb:(color JJ2 JK2 JL2) multiplier:JM2 castShadows:JN2
shadowMultiplier:JO2 lightAffectsShadow:JP2 showCone:JQ2 coneShape:JR2 aspect:JS2
hotspot:JT2 falloff:JU2 pos:[JV2,JW2,JX2] isSelected:on

---
```

```
Directionallight name:"JI2" rgb:(color JJ2 JK2 JL2) multiplier:JM2 castShadows:JN2
shadowMultiplier:JO2 lightAffectsShadow:JP2 showCone:JQ2 coneShape:JR2 aspect:JS2
hotspot:JT2 falloff:JU2 pos:[JV2,JW2,JX2] isSelected:on

---

Omnilight name:"JI2" rgb:(color JJ2 JK2 JL2) multiplier:JM2 castShadows:JN2
shadowMultiplier:JO2 lightAffectsShadow:JP2 pos:[JV2,JW2,JX2] isSelected:on
```

Sub-Formula for Cone Shape

```
=SE(JR2=0;"";SE(JR2="Circle";"1";SE(JR2="Rectangle";"2")))
```

The formula for photometric lights - artificial

```
MN2 name:"MO2" Multiplier:MP2 intensityType:0 flux:MQ2 intensityAt:MR2
light_length:MS2 light_width:MT2 light_radius:MU2 distribution:MV2 showCone:MW2
hotspot:MX2 falloff:MY2 castShadows:MZ2 shadowMultiplier:NA2
lightAffectsShadow:NB2 useKelvin:on kelvin:NC2 pos:[ND2,NE2,NF2] isSelected:on
target:(Targetobject pos:[NG2,NH2,NI2])
```

```
=SE(MN2=0;"";SE(MN2="Free_Point";CONCATENAR("Free_Point name:""";MO2;"""";"
Multiplier:";MP2;" intensityType:0 flux:";MQ2;" intensityAt:";MR2;"
light_length:";MS2;" light_width:";MT2;" light_radius:";MU2;"
distribution:";MV2;" showCone:";MW2;" hotspot:";MX2;" falloff:";MY2;"
castShadows:";MZ2;" shadowMultiplier:";NA2;" lightAffectsShadow:";NB2;"
useKelvin:on kelvin:";NC2;" pos:[";ND2;",";NE2;",";NF2;"]
isSelected:on";CARACT(10));SE(MN2="Free_Linear";CONCATENAR("Free_Linear
name:""";MO2;"""";" Multiplier:";MP2;" intensityType:0 flux:";MQ2;"
intensityAt:";MR2;" light_length:";MS2;" light_width:";MT2;"
light_radius:";MU2;" distribution:";MV2;" showCone:";MW2;" hotspot:";MX2;"
falloff:";MY2;" castShadows:";MZ2;" shadowMultiplier:";NA2;"
lightAffectsShadow:";NB2;" useKelvin:on kelvin:";NC2;"
pos:[";ND2;",";NE2;",";NF2;"]
isSelected:on";CARACT(10));SE(MN2="Free_Area";CONCATENAR("Free_Area
name:""";MO2;"""";" Multiplier:";MP2;" intensityType:0 flux:";MQ2;"
intensityAt:";MR2;" light_length:";MS2;" light_width:";MT2;"
light_radius:";MU2;" distribution:";MV2;" showCone:";MW2;" hotspot:";MX2;"
falloff:";MY2;" castShadows:";MZ2;" shadowMultiplier:";NA2;"
lightAffectsShadow:";NB2;" useKelvin:on kelvin:";NC2;"
pos:[";ND2;",";NE2;",";NF2;"]
isSelected:on";CARACT(10));SE(MN2="Free_Disc";CONCATENAR("Free_Disc
name:""";MO2;"""";" Multiplier:";MP2;" intensityType:0 flux:";MQ2;"
intensityAt:";MR2;" light_length:";MS2;" light_width:";MT2;"
light_radius:";MU2;" distribution:";MV2;" showCone:";MW2;" hotspot:";MX2;"
falloff:";MY2;" castShadows:";MZ2;" shadowMultiplier:";NA2;"
lightAffectsShadow:";NB2;" useKelvin:on kelvin:";NC2;"
pos:[";ND2;",";NE2;",";NF2;"]
isSelected:on";CARACT(10));SE(MN2="Free_Sphere";CONCATENAR("Free_Sphere
name:""";MO2;"""";" Multiplier:";MP2;" intensityType:0 flux:";MQ2;"
intensityAt:";MR2;" light_length:";MS2;" light_width:";MT2;"
light_radius:";MU2;" distribution:";MV2;" showCone:";MW2;" hotspot:";MX2;"
falloff:";MY2;" castShadows:";MZ2;" shadowMultiplier:";NA2;"
lightAffectsShadow:";NB2;" useKelvin:on kelvin:";NC2;"
pos:[";ND2;",";NE2;",";NF2;"]
isSelected:on";CARACT(10));SE(MN2="Free_Cylinder";CONCATENAR("Free_Cylinder
name:""";MO2;"""";" Multiplier:";MP2;" intensityType:0 flux:";MQ2;"
```

```
intensityAt:";MR2;" light_length:";MS2;" light_width:";MT2;"
light_radius:";MU2;" distribution:";MV2;" showCone:";MW2;" hotspot:";MX2;"
falloff:";MY2;" castShadows:";MZ2;" shadowMultiplier:";NA2;"
lightAffectsShadow:";NB2;" useKelvin:on kelvin:";NC2;"
pos:[";ND2;",";NE2;",";NF2;"]
isSelected:on";CARACT(10));SE(MN2="Target_Point";CONCATENAR("Target_Point
name:""";MO2;"""";" Multiplier:";MP2;" intensityType:0 flux:";MQ2;"
intensityAt:";MR2;" light_length:";MS2;" light_width:";MT2;"
light_radius:";MU2;" distribution:";MV2;" showCone:";MW2;" hotspot:";MX2;"
falloff:";MY2;" castShadows:";MZ2;" shadowMultiplier:";NA2;"
lightAffectsShadow:";NB2;" useKelvin:on kelvin:";NC2;"
pos:[";ND2;",";NE2;",";NF2;"] isSelected:on target:(Targetobject
pos:[";NG2;",";NH2;",";NI2;"])";CARACT(10);"select
$Target001";CARACT(10);"$.name=""";MO2;".Target""";CARACT(10));"")))))&SE(M
N2="Target_Linear";CONCATENAR("Target_Linear name:""";MO2;"""";"
Multiplier:";MP2;" intensityType:0 flux:";MQ2;" intensityAt:";MR2;"
light_length:";MS2;" light_width:";MT2;" light_radius:";MU2;"
distribution:";MV2;" showCone:";MW2;" hotspot:";MX2;" falloff:";MY2;"
castShadows:";MZ2;" shadowMultiplier:";NA2;" lightAffectsShadow:";NB2;"
useKelvin:on kelvin:";NC2;" pos:[";ND2;",";NE2;",";NF2;"] isSelected:on
target:(Targetobject pos:[";NG2;",";NH2;",";NI2;"])";CARACT(10);"select
$Target001";CARACT(10);"$.name=""";MO2;".Target""";CARACT(10));SE(MN2="Targ
et_Area";CONCATENAR("Target_Area name:""";MO2;"""";" Multiplier:";MP2;"
intensityType:0 flux:";MQ2;" intensityAt:";MR2;" light_length:";MS2;"
light_width:";MT2;" light_radius:";MU2;" distribution:";MV2;"
showCone:";MW2;" hotspot:";MX2;" falloff:";MY2;" castShadows:";MZ2;"
shadowMultiplier:";NA2;" lightAffectsShadow:";NB2;" useKelvin:on
kelvin:";NC2;" pos:[";ND2;",";NE2;",";NF2;"] isSelected:on
target:(Targetobject pos:[";NG2;",";NH2;",";NI2;"])";CARACT(10);"select
$Target001";CARACT(10);"$.name=""";MO2;".Target""";CARACT(10));SE(MN2="Targ
et_Disc";CONCATENAR("Target_Disc name:""";MO2;"""";" Multiplier:";MP2;"
intensityType:0 flux:";MQ2;" intensityAt:";MR2;" light_length:";MS2;"
light_width:";MT2;" light_radius:";MU2;" distribution:";MV2;"
showCone:";MW2;" hotspot:";MX2;" falloff:";MY2;" castShadows:";MZ2;"
shadowMultiplier:";NA2;" lightAffectsShadow:";NB2;" useKelvin:on
kelvin:";NC2;" pos:[";ND2;",";NE2;",";NF2;"] isSelected:on
target:(Targetobject pos:[";NG2;",";NH2;",";NI2;"])";CARACT(10);"select
$Target001";CARACT(10);"$.name=""";MO2;".Target""";CARACT(10));SE(MN2="Targ
et_Sphere";CONCATENAR("Target_Sphere name:""";MO2;"""";" Multiplier:";MP2;"
intensityType:0 flux:";MQ2;" intensityAt:";MR2;" light_length:";MS2;"
light_width:";MT2;" light_radius:";MU2;" distribution:";MV2;"
showCone:";MW2;" hotspot:";MX2;" falloff:";MY2;" castShadows:";MZ2;"
shadowMultiplier:";NA2;" lightAffectsShadow:";NB2;" useKelvin:on
kelvin:";NC2;" pos:[";ND2;",";NE2;",";NF2;"] isSelected:on
target:(Targetobject pos:[";NG2;",";NH2;",";NI2;"])";CARACT(10);"select
$Target001";CARACT(10);"$.name=""";MO2;".Target""";CARACT(10));SE(MN2="Targ
et_Cylinder";CONCATENAR("Target_Cylinder name:""";MO2;"""";"
Multiplier:";MP2;" intensityType:0 flux:";MQ2;" intensityAt:";MR2;"
light_length:";MS2;" light_width:";MT2;" light_radius:";MU2;"
distribution:";MV2;" showCone:";MW2;" hotspot:";MX2;" falloff:";MY2;"
castShadows:";MZ2;" shadowMultiplier:";NA2;" lightAffectsShadow:";NB2;"
useKelvin:on kelvin:";NC2;" pos:[";ND2;",";NE2;",";NF2;"] isSelected:on
target:(Targetobject pos:[";NG2;",";NH2;",";NI2;"])";CARACT(10);"select
$Target001";CARACT(10);"$.name=""";MO2;".Target""";CARACT(10));"")))))))
```

REPLACE MV2 BY THE CELL WHERE THE SUB-FORMULA WILL BE !!!

Distribution Sub-Formula

```
=SE(MV2=0;"";SE(MV2="Uniform Sphereical";"0";SE(MV2="Spotlight (not valid
for Sphere and Cylinder types)";"1";SE(MV2="Uniform Hemispherical (not
valid for Sphere and Cylinder types)";"2";SE(MV2="Photometric Web File (not
valid for Sphere and Cylinder types)";"3";)))))
```

REFERENCE BALLS

The formula for REFERENCE BALLS

The formula for gray sphere 18%

```
Sphere name:"QC2" radius:QD2 segs:QE2 smooth:on recenter:on pos:[QG2,QH2,QI]
isSelected:on

meditMaterials[1].Diffuse=color 128 128 128

meditMaterials[1].ambient=color 128 128 128

meditMaterials[1].name="QC2 material"

$'QC2'.material=meditMaterials[1]

=SE(QF2=0;"";SE(QF2="Grey color (18% relative
luminosity)";CONCATENAR("Sphere name:""";QC2;"""";" radius:";QD2;"
segs:";QE2;" smooth:on recenter:on pos:[";QG2;",";QH2;",";QI2;"]
isSelected:on";CARACT(10);"meditMaterials[1].Diffuse=color 128 128
128";CARACT(10); "meditMaterials[1].ambient=color 128 128
128";CARACT(10);"meditMaterials[1].name=""";QC2;"
material""";CARACT(10);"$'";QC2;"'.material=meditMaterials[1]";CARACT(10));
SE(QF2="White color (styrofoam ball)";CONCATENAR("Sphere
name:""";QC2;"""";" radius:";QD2;" segs:";QE2;" smooth:on recenter:on
pos:[";QG2;",";QH2;",";QI2;"]
isSelected:on";CARACT(10);"meditMaterials[1].Diffuse=color 255 255
255";CARACT(10); "meditMaterials[1].ambient=color 255 255
255";CARACT(10);"meditMaterials[1].name=""";QC2;"
material""";CARACT(10);"$'";QC2;"'.material=meditMaterials[1]";CARACT(10));
)))
```

The formula for mirrored gray sphere

```
Sphere name:"QJ2" radius:QK2 segs:QL2 smooth:on recenter:off
pos:[QM2,QN2,QO2] isSelected:on

meditMaterials[2]=Architectural()

meditMaterials[2].template="Mirror"

meditMaterials[2].name="QJ2 material"

$'QJ2'.material=meditMaterials[2]

=SE(QB2=0;"";SE(QB2="No, go to the next type of reference
object.";"";SE(QB2="Yes, I want to collect data for the creation of virtual
reference balls.";CONCATENAR("Sphere name:""";QJ2;"""";" radius:";QK2;"
segs:";QL2;" smooth:on recenter:on pos:[";QM2;",";QN2;",";QO2;"]
isSelected:on";CARACT(10);"meditMaterials[2]=Architectural()";CARACT(10);"m
editMaterials[2].template=""";"Mirror";"""";CARACT(10);"meditMaterials[2].n
ame=""";QJ2;"
```

```
material""";CARACT(10);"$'";QJ2;"'.material=meditMaterials[2]";CARACT(10);)
)))
```

REFERENCE PLAN

The formula for REFERENCE PLAN

```
-- flat with standard white material
Plane name:"QR2" length:QS2 width:QT2 wirecolor:white pos:[QU2,QV2,QW2]
isSelected:on

-- plane with matte/shadow material
Plane name:"QR2" length:QS2 width:QT2 pos:[QU2,QV2,QW2] isSelected:on
meditMaterials[3]=MatteShadow()
meditMaterials[3].name="QR2 material"
$'QR2'.material=meditMaterials[3]

-- plan with mental ray material -> matte/shadow/reflection
renderers.production=mental_ray_renderer()
renderers.current=mental_ray_renderer()

Plane name:"QR2" length:QS2 width:QT2 pos:[QU2,QV2,QW2] isSelected:on
meditMaterials[3]=Matte_Shadow_Reflection__mi()
meditMaterials[3].catch_reflections=on
meditMaterials[3].name="QR2 material"
$'QR2'.material=meditMaterials[3]

=SE(QQ2=0;"";SE(QQ2="Standard plane without assigned material - (Default
Scanline Renderer)";CONCATENAR("Plane name:""";QR2;"""";" length:";QS2;"
width:";QT2;" wirecolor:white pos:[";QU2;",";QV2;",";QW2;"]
isSelected:on";CARACT(10));SE(QQ2="Matte / Shadow Material - (Default
Scanline Renderer)";CONCATENAR("Plane name:""";QR2;"""";" length:";QS2;"
width:";QT2;" pos:[";QU2;",";QV2;",";QW2;"]
isSelected:on";CARACT(10);"meditMaterials[3]=MatteShadow()";CARACT(10);"med
itMaterials[3].name=""";QR2;"
material""";CARACT(10);"$'";QR2;"'.material=meditMaterials[3]";CARACT(10));
SE(QQ2="Matte / Shadow / Reflection Material - (Mental Ray
Renderer)";CONCATENAR("renderers.production=mental_ray_renderer()";CARACT(1
0);"renderers.current=mental_ray_renderer()";CARACT(10);"Plane
name:""";QR2;"""";" length:";QS2;" width:";QT2;"
pos:[";QU2;",";QV2;",";QW2;"]
isSelected:on";CARACT(10);"meditMaterials[3]=Matte_Shadow_Reflection__mi()"
;CARACT(10);"meditMaterials[3].catch_reflections=on";CARACT(10);"meditMater
ials[3].name=""";QR2;"
material""";CARACT(10);"$'";QR2;"'.material=meditMaterials[3]";CARACT(10)))
)))
```

REFERENCE ROD

The formula for REFERENCE ROD

```
mybox=box length:QZ2 width:QZ2 height:RA2 wirecolor:blue pos:[RC2,RD2,RE2]
for i=1 to SZ2 do
(
box_copy=copy mybox
```

```
box_copy.pos=[RC2,RD2,RE2+i*RA2]
box_copy.wirecolor=[i*25,i*50,(5-i)*50]
)
group $box* name:"QY2"

=SE(QX2=0;"";SE(QX2="No, go to the next step.";"";SE(QX2="Yes, I want to
collect data for the creation of virtual reference
rod.";CONCATENAR("mybox=box length:";QZ2;" width:";QZ2;" height:";RA2;"
wirecolor:blue pos:[";RC2;",";RD2;",";RE2;"]";CARACT(10);"for i=1 to
";SZ2;" do";CARACT(10);"(";CARACT(10);"box_copy=copy
mybox";CARACT(10);"box_copy.pos=[";RC2;",";RD2;",";RE2;"+i*";RA2;
"]";CARACT(10);"box_copy.wirecolor=[i*25,i*50,(5-
i)*50]";CARACT(10);")";CARACT(10); "group $box*
name:""";QY2;"""";CARACT(10)))))
```

Subtraction sub-formula RefRod

```
=SE(RB2=0;"";(RB2-1))
```

The formula for Data Collection for Render Setup + Presets for 3ds Max File

```
actionMan.executeAction 0 "219"
actionMan.executeAction 0 "160"

renderWidth=RF2
renderHeight=RG2
renderPixelAspect=RH2

frameRate=RI2
timeDisplayMode=RJ2
units.DisplayType=RK2


=CONCATENAR("actionMan.executeAction 0 """;"219";"""";CARACT(10);
"actionMan.executeAction 0
""";"160";"""";CARACT(10);"renderWidth=";RF2;CARACT(10);"renderHeight=";RG2
;CARACT(10);"renderPixelAspect=";RH2;CARACT(10);"frameRate=";RI2;CARACT(10)
;"timeDisplayMode=";RJ2;CARACT(10);"units.DisplayType=";RK2;CARACT(10);)
```

V. Example of a script in MaxScript language

Here is a script created by the tool (DLO) using the color format of the MaxScript programming language (different from the example shown in illustration Figure 4.13 in the body of the thesis, where the image is presented in the color format with which it is sent to the user by email, in order to reinforce the importance of not changing the document and with bold and color reinforcement for the user name, the scene name, and instructions on how to correctly download the file).

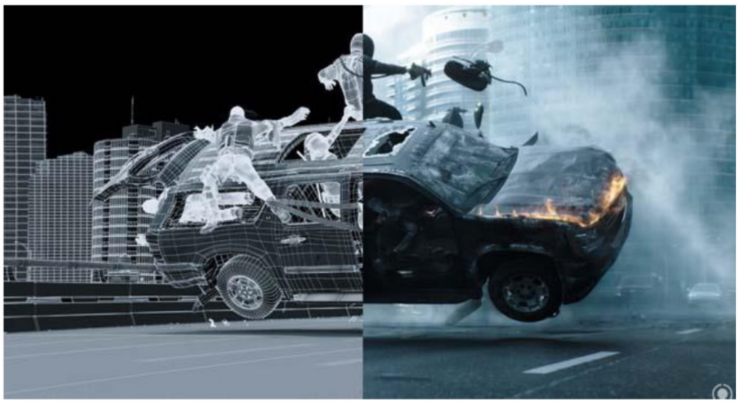
```
-- Dear user Josualdo Tremembé.


-- This is your script file for 3ds Max software with your scene named:
-- “Praça Mortífera”.


-- Do not change anything in this document.
-- To save the archive to your computer properly (download) follow the instruction below:


-- a) Select the "File" option;
-- b) Go to the "Download as" option;
-- c) Choose the option "Plain Text (.txt)".


-- Ready, after saving the file in the format (.txt) your Script can already be opened by 3ds Max with
this extension, however, if you prefer, you can also rename the extension later to (.ms) "3dsMax
maxscript file". The functioning is the same.


-- To execute the Script in the software, just go to "Scripting" tab beside Help, and select "Run Script
..."
-- If necessary, change the "Files of type" option to "Text file (* .txt)" if you haven't renamed to the
maxscript extension (* .ms).


-- Script start
--------------------------------------------------------------------------------
messageBox "Dear Josualdo Tremembé click OK to the 3DS Max run the script and follow the
instructions that can appear, if necessary."
resetMaxFile #noprompt --reset the scene
--------------------------------------------------------------------------------
-- Legacy Cameras

Freecamera fov:33 targetDistance:131 clipManually:off nearclip:1 farclip:1000 showRanges:off nearra
nge:0 farrange:1000 showCone:on showHorizon:off mpassEnabled:off mpassRenderPerPass:off pos
:[100,-100,100] isSelected:on
$.name="Cannon MKII 5D"
rotate $ (angleaxis 90 [1,0,0])
rotate $ (angleaxis -10 [1,0,0])
rotate $ (angleaxis 0 [0,1,0])
rotate $ (angleaxis 25 [0,0,1])

Freecamera fov:33 targetDistance:130 clipManually:off nearclip:1 farclip:1000 showRanges:off nearra
nge:0 farrange:1000 showCone:on showHorizon:off mpassEnabled:off mpassRenderPerPass:off pos
:[0,-100,50] isSelected:on
$.name="Nikon IOO9"
```

```
$'Nikon IOO9'.type=#target
$'Nikon IOO9.Target'.pos=[0,0,0]
rotate $ (angleaxis 0 [0,1,0])

------------------------------------------------------------------------------
-- Physical Cameras

Physical targeted:off exposure_value:6 film_preset:"APS-C
(Nikon)" film_width_mm:23.7 fov:55 name:"Sharp TT
83" focal_length_mm:40 zoom_factor:1 f_number:8 use_dof:off show_camera_cone:0 motion_blur_en
abled:off target_distance:200 horizon_on:off white_balance_illuminant:5 environment_near:0 environ
ment_far:40000 clip_on:off clip_near:0 clip_far:39000 specify_focus:1 focus_distance:100 pos:[-100,-
100,100] isSelected:on
$.targeted=on
$'Sharp TT 83.Target'.pos=[0,0,0]
rotate $ (angleaxis 0 [0,1,0])

------------------------------------------------------------------------------
-- Artificial Lights
------------------------------------------------------------------------------
--Standard Lights

TargetDirectionallight name:"Makulele
Luz" rgb:(color 255 255 255) multiplier:1 castShadows:on shadowMultiplier:.5 lightAffectsShadow:off
showCone:on coneShape:2 aspect:1 hotspot:43 falloff:45 pos:[100,0,200] isSelected:on target:(Targe
tobject pos:[0,0,0])
select $Target001
$.name="Makulele Luz.Target"

targetSpot name:"Luz
primeira" rgb:(color 255 255 255) multiplier:1 castShadows:on shadowMultiplier:.8 lightAffectsShadow
:on showCone:on coneShape:1 aspect:55 hotspot:500 falloff:22 pos:[0,0,4] isSelected:on target:(Targ
etobject pos:[0,0,0])
select $Target001
$.name="Luz primeira.Target"

Directionallight name:"Directional Light
Malandra" rgb:(color 255 255 255) multiplier:1.2 castShadows:on shadowMultiplier:.3 lightAffectsShad
ow:on showCone:on coneShape:1 aspect:.34 hotspot:43 falloff:58 pos:[-6,4,3] isSelected:on

Omnilight name:"Omni test
Light" rgb:(color 55 77 66) multiplier:1 castShadows:on shadowMultiplier:.4 lightAffectsShadow:on po
s:[6,-5,5] isSelected:on

--Photometric Lights

Free_Cylinder name:"Fluorescente
bitela" Multiplier:100 intensityType:0 flux:1000 intensityAt:40 light_length:122 light_width:61 light_radiu
s:13 distribution:0 showCone:on hotspot:43 falloff:45 castShadows:on shadowMultiplier:.5 lightAffects
Shadow:off useKelvin:on kelvin:5500 pos:[-100,0,200] isSelected:on

Free_Linear name:"Linear muito
louca" Multiplier:90 intensityType:0 flux:3000 intensityAt:40 light_length:22 light_width:10 light_radius:.
3 distribution:2 showCone:on hotspot:40 falloff:45 castShadows:on shadowMultiplier:.5 lightAffectsSh
adow:off useKelvin:on kelvin:3200 pos:[-2,-2,2] isSelected:on

Target_Disc name:"Disk Light
Maluquete" Multiplier:50 intensityType:0 flux:6000 intensityAt:60 light_length:100 light_width:60 light_r
adius:10 distribution:1 showCone:on hotspot:20 falloff:32 castShadows:on shadowMultiplier:0.4 lightA
ffectsShadow:off useKelvin:on kelvin:6000 pos:[-3,3,3] isSelected:on target:(Targetobject pos:[0,0,0])
```

```
select $Target001
$.name="Disk Light Maluquete.Target"

--------------------------------------------------------------------------------
-- Reference Objects
--------------------------------------------------------------------------------
-- Reference Spheres

Sphere name:"Cinza pequena" radius:10 segs:32 smooth:on recenter:on pos:[10,0,0] isSelected:on
meditMaterials[1].Diffuse=color 128 128 128
meditMaterials[1].ambient=color 128 128 128
meditMaterials[1].name="Cinza pequena material"
$'Cinza pequena'.material=meditMaterials[1]

Sphere name:"Espelhada Maluca" radius:10 segs:32 smooth:on recenter:on pos:[-
10,0,0] isSelected:on
meditMaterials[2]=Architectural()
meditMaterials[2].template="Mirror"
meditMaterials[2].name="Espelhada Maluca material"
$'Espelhada Maluca'.material=meditMaterials[2]

--------------------------------------------------------------------------------
-- Reference Plane

Plane name:"Plano para recair sombras" length:30 width:30 pos:[0,0,0] isSelected:on
meditMaterials[3]=MatteShadow()
meditMaterials[3].name="Plano para recair sombras material"
$'Plano para recair sombras'.material=meditMaterials[3]

--------------------------------------------------------------------------------
-- Reference Rod

mybox=box length:3 width:3 height:3 wirecolor:blue pos:[0,-3,0]
for i=1 to 7 do
(
box_copy=copy mybox
box_copy.pos=[0,-3,0+i*3]
box_copy.wirecolor=[i*25,i*50,(5-i)*50]
)
group $box* name:"Bastonete referencia"

--------------------------------------------------------------------------------
-- Settings - Render Setup and Presets for 3ds Max File

actionMan.executeAction 0 "219"
actionMan.executeAction 0 "160"
renderWidth=1920
renderHeight=1080
renderPixelAspect=1
frameRate=24
timeDisplayMode=#smpte
units.DisplayType=#Metric

--------------------------------------------------------------------------------

max select all
max freeze selection
if queryBox "The elements created by Script are frozen by default, would you like to unfreeze them all
now?" beep:false then ((max unfreeze all); (messageBox "Ok, all the elements have been thawed and
are ready for use."))        else (messageBox "OK! the elements will remain frozen.")
```

```
--------------------------------------------------------------------------------
-- Natural Lights

theInt=DaylightSystemFactory2.Create sunClass:IES_Sun skyClass:IES_Sky
$Daylight001.manual=0
max display mode
max motion mode
messageBox "Attention ! \n \nThere is no way to enter the data related to natural light automatically through by Script. \nFor this reason, note down the data below because clicking on 'OK' will close this message (you can not see this message and enter the natural light data in the tab at the right side of the screen at the same time). \nAfter annotating the data, click 'OK' to close this warning screen for can insert the data. \nIf you do not want to write down, the data below is also on the copy of the completed form that was sent by e-mail. \n \nIf you have a weather file (Weather Data File - *.epw) you can select this option in 'Control Parameters' to select your file and then set the date and time. \n \nIn 'Motion' guide \nTime: \nHours/Mins./Secs.: 13:00:00 \nMonth/Day/Year: 29/04/1999 \nTime Zone: -3 \nDaylight Saving Time: off \n \nLocation: \nLatitude: 30 \nLongitude: 45 \nNorth Direction: 0 \n \nIn 'Modify' guide \nFor 'mr_Sky' class for Sky (Models: Perez All-Weather and CIE) \nDiffuse Horizontal Illuminance: 15000 \nDirect Normal Illuminance: 15000 \n \nSky Coverage (for IES_Sky classes): Clear \nSky Coverage (for mr_Sky classes and CIE Sky Model): Clear Sky \n \nYour Script was set successfully, good use! \n \nMaschio, A. V."

-- Script end
```

VI. Poster for the dissemination of the mini-course and preliminary consultation of interest



Conheça os princípios básicos para integração verossímil

Adquira noção das técnicas e tecnologias envolvidas

Compreenda o fluxo de trabalho

Investigue sua vocação para a área de efeitos visuais

Reflita sobre quais das diversas áreas gostaria de se especializar

JULHO / AGOSTO

CONCEITOS BÁSICOS PARA INTEGRAÇÃO ENTRE IMAGENS REAIS E VIRTUAIS EM AUDIOVISUAL

Formulário de Consulta de Interesse

Acesse pelo link abaixo ou QR Code o formulário de interesse para o Minicurso / Pesquisa que será ministrado em breve.

O curso estará aberto a alunos dos seguintes cursos de graduação: **Mídias Digitais**; **Rádio e TV**; **Cinema e Audiovisual**.

Sua manifestação de interesse é importante tanto para conhecer melhor o perfil dos alunos interessados, como para o planejamento da carga-horária do curso de acordo com a disponibilidade de horário da maioria dos interessados.

A previsão é que o curso se inicie no mês de julho e vá até o mês de agosto, com duração aproximada de 4 semanas (1 mês). Será ministrado nas instalações do Departamento de Mídias Digitais.

Link para acesso ao formulário através do link ou QR Code abaixo:
https://goo.gl/forms/LeLhjln6KyS8v0Bs1

UFPB DEMID
Departamento de Mídias Digitais

PROF. RESPONSÁVEL
Alexandre Vieira Maschio

E-mail
maschio@outlook.com

FCT FACULDADE DE CIÊNCIAS E TECNOLOGIA UNIVERSIDADE NOVA DE LISBOA

VII. Preliminary Interest Consultation Form

Consulta de interesse em participação em minicurso/pesquisa.

*Obrigatório

1. Endereço de e-mail *

2. Nome Completo *

Descrição do minicurso/pesquisa

Título: Conceitos básicos para integração de imagens reais e virtuais em produtos audiovisuais

Proposição: Ensino de conceitos básicos necessários para que a integração entre imagens reais (live action) e imagens virtuais (CGI – imagens geradas por computador - computação gráfica) possam se integrar de forma verossímil. Elementos teóricos, técnicos e tecnológicos envolvidos na produção audiovisual onde a composição de elementos reais e virtuais se faz necessária.

Objetivo: Ensinar os conceitos básicos de integração verossímil entre imagens reais e virtuais, utilizando tanto exposição teórica quanto exercícios práticos para melhor compreensão dos inúmeros conceitos, técnicas e tecnologias envolvidos.

Pré-requisitos (não limitantes para participação no minicurso/pesquisa): conhecimentos no idioma inglês; conhecimentos prévios em softwares como: edição (Premiere), composição/pós-produção (After Effects), edição de imagens (Photoshop), computação gráfica (3DS Max); conhecimentos e habilidades em filmagem (manipulação e configuração de câmeras de vídeo e DSLR's); conhecimentos relativos a fotografia e direção de fotografia/iluminação cinematográfica.

Certificação: além de aprender um pouco mais sobre o tema, os participantes serão certificados através da parceria com o Projeto DIAS (Design Instrucional para uma Aprendizagem Significativa), coordenado pela Prof.ª Dr.ª Signe Dayse. Desta forma poderão contabilizar as horas para as atividades extracurriculares a serem cumpridas durante seus respectivos cursos de graduação (aos alunos que concluírem todo o minicurso/pesquisa com presença mínima de 75% e conclusão das atividades propostas).

Palavras-chave: Visual Effects, VFX (efeitos visuais), Match Moving.

Sobre -> este pré-cadastro/consulta

O professor do DEMID (Departamento de Mídias Digitais) da UFPB, Alexandre Vieira Maschio, atualmente cursando seu "Doutoramento em Media Digitais" na Faculdade de Tecnologia da Universidade Nova de Lisboa (FCT-UNL), intenciona ministrar o referido minicurso/pesquisa junto aos alunos dos cursos de "Mídias Digitas" e "Cinema e Audiovisual" da UFPB. O minicurso/pesquisa faz parte do desenvolvimento de sua investigação de doutoramento.
A atividade conta com o apoio do departamento e coordenação do curso de Comunicação em Mídias Digitais, na figura dos professores André Sonoda e Signe Dayse. A respectiva pesquisa também está amparada pelo comitê de ética em pesquisa da UFPB.

Para que -> este pré-cadastro/consulta

Este pré-cadastro servirá para que o investigador possa ter uma noção prévia da quantidade de alunos interessados e qual a disponibilidade dos mesmos para participar do minicurso/pesquisa. No mais, tenta levantar um perfil inicial dos conhecimentos prévios dos alunos interessados (sobre algumas áreas/assuntos/técnicas/tecnologias) para o desenvolvimento mais assertivo do conteúdo e método pedagógico a ser empregado.

Alerta -> vaga para participação

Este pré-cadastro não é garantidor de vaga para a participação no referido minicurso/pesquisa, pois a infraestrutura para a realização das atividades ainda está sendo avaliada (laboratório de computadores, quantidade de computadores disponíveis, disponibilidade de estúdio, equipamentos de iluminação e filmagem, entre diversos outros). Por este motivo, a quantidade de alunos a participar do minicurso/pesquisa poderá ser limitada. Caso haja maior número de interessados que o número de vagas disponíveis, será dada preferência aos alunos dos semestres mais avançados, em razão de já terem cumprido um número maior de disciplinas e terem, em teoria, maior repertório na área (no caso de pessoas em lista de espera, os mesmos poderão ser contatados caso haja desistências no primeiro dia de atividade).

Após futuramente definidas as datas e horários das atividades (com o auxílio desta consulta), o link para a inscrição será divulgado por e-mail para os que tiverem feito este pré-cadastro, além de também ser disponibilizado através de outros suportes, como grupos de Facebook, ou comunicações diretas feitas através das coordenações de curso e centros acadêmicos (por e-mail, grupos ou outros meios de comunicação em uso).

Em caso de dúvidas com respeito aos aspectos éticos desta pesquisa, você poderá consultar:

Pesquisador Responsável: Alexandre Vieira Maschio
Endereço: Rua Luiz Roher, nº 890, Jardim Ricetti, São Carlos – SP.
CEP: 13.570-002
Fone: (16) 9.9626-7134
E-mail: maschio@outlook.com

Ou

Comitê de Ética em Pesquisa do Centro de Ciências da Saúde da Universidade Federal da Paraíba Campus I - Cidade Universitária - 1º Andar – CEP 58051-900 – João Pessoa/PB
Fone: (83) 3216-7791 – E-mail: comitedeetica@ccs.ufpb.br

Iniciar preenchimento de formulário

Prossiga para iniciar

Informações acadêmicas.

3. Você encontra-se em que ano de seu curso de graduação? *

Marcar apenas uma oval.

- Primeiro ano (1º ou 2º semestre)
- Segundo ano (3º ou 4º semestre)
- Terceiro ano (5º ou 6º semestre)
- Quarto ano (7º ou 8º semestre)
- Já me formei (egresso)

4. Qual das situações abaixo descreve sua situação? *

Marcar apenas uma oval.

- ( ) Sou aluno regularmente matriculado no curso de Comunicação em Mídias Digitais da UFPB *Pular para a pergunta 7*
- ( ) Sou aluno regularmente matriculado no curso de Cinema e Audiovisual da UFPB *Pular para a pergunta 7*
- ( ) Sou aluno regularmente matriculado no curso de Radialismo da UFPB
- ( ) Sou aluno já formado (egresso) do curso de Comunicação em Mídias Digitais da UFPB *Pular para a pergunta 7*
- ( ) Sou aluno já formado (egresso) do curso de Cinema e Audiovisual da UFPB *Pular para a pergunta 7*
- ( ) Sou aluno já formado (egresso) do curso de Radialismo da UFPB
- ( ) Sou aluno de curso da área audiovisual (nível graduação), mas de outra instituição (pública ou privada) *Pular para a pergunta 5*
- ( ) Não sou aluno ou ex-aluno de nenhuma instituição de ensino de nível superior, mas tenho interesse em participar de cursos desta temática em outra oportunidade (curso de extensão, por exemplo) *Pular para a seção 4 (Registro de interesse futuro)*

Pular para a pergunta 7

Aluno de outra instituição

Pública ou privada

5. Qual no nome de seu respectivo curso da área audiovisual? *

____

6. Qual o nome de sua instituição de ensino? *

____

Pular para a pergunta 7

Registro de interesse futuro

Infelizmente você não faz parte do perfil para a pesquisa que será realizada concomitantemente ao minicurso que será ministrado.
No mais, agradecemos o contato e sua manifestação, pois com ela será possível ter informações sobre futuros interessados em participar em cursos desta temática.
Muito obrigado.

Interesse e disponibilidade

Possibilidades de oferta do minicurso / pesquisa

Obs. **01**: Para atender a um número maior de alunos estes trabalharão no laboratório de computadores em duplas (2 alunos por computador) e serão constituídas 2 turmas distintas para se obter um número de participantes suficiente para o quórum necessário para posterior validação estatística da pesquisa.

Obs. **02**: Levar em consideração as distintas cargas horárias entre as possibilidades. Uma das opções possibilita maior carga horária, levando a um curso mais extenso e menos compacto.

Obs. **03**: Ainda não há confirmação da possibilidade da oferta do curso aos finais de semana, devido a logística necessária junto ao Centro de Ciências Humanas Letras e Artes (CCHLA) e à prefeitura do câmpus, devido à segurança e abertura e fechamento do edifício e laboratórios.

Possibilidade de oferta 01

Curso no período **noturno** em dias alternados (dia sim, dia não - para intercalação entre 2 turmas)
De **segunda-feira** à **sexta-feira** durante 4 semanas - total de 10 encontros de 3 horas cada
Carga horária total do curso de **30 horas**

Possibilidade de oferta 02

Curso no período **noturno** e **matutino** em períodos alternados (primeiro dia no período da manhã, segundo dia no período da noite para a turma 01 e o inverso para a turma 02 e assim sucessivamente - para intercalação entre 2 turmas)
De **segunda-feira** à **sexta-feira** durante 4 semanas - total de 20 encontros de 3 horas cada
Carga horária total do curso de **60 horas**

Possibilidade de oferta 03

Curso no período **matutino** e **vespertino** em períodos alternados (primeiro dia no período da manhã, segundo dia no período da tarde para a turma 01 e o inverso para a turma 02 - para intercalação entre 2 turmas)
Aos **sábados** e **domingos** durante 4 semanas - total de 8 encontros de 4 horas cada
Carga horária total do curso de **32 horas**

Considerando que você já está respondendo a este formulário para manifestar e registrar seu interesse em participar do minicurso/pesquisa:

Além de considerar que as aulas dos cursos de graduação da UFPB são normalmente no período vespertino e alguns alunos realizam estágio no período matutino.

7. Em quais das três possibilidades de oferta você teria interesse e DISPONIBILIDADE para participar? *

Assinale todas as alternativas em que possui disponibilidade.

Marque todas que se aplicam.

- [ ] Possibilidade de oferta 01 (apenas noturno) - durante a semana - 30 horas de carga horária
- [ ] Possibilidade de oferta 02 (matutino e noturno) - durante a semana - 60 horas de carga horária
- [ ] Possibilidade de oferta 03 (matutino e vespertino) - finais de semana - 32 horas de carga horária

8. **Entre as três possibilidades de oferta qual você tem preferência?** *

Escolha apenas uma opção.

Marcar apenas uma oval.

- ( ) Possibilidade de oferta 01 (apenas noturno) - durante a semana - 30 horas de carga horária
- ( ) Possibilidade de oferta 02 (matutino e noturno) - durante a semana - 60 horas de carga horária
- ( ) Possibilidade de oferta 03 (matutino e vespertino) - finais de semana - 32 horas de carga horária

Conhecimento Prévio

Este item é importante para que o professor compreenda melhor o perfil dos estudantes interessados em participar do minicurso/pesquisa, pois como o curso envolve muitos conhecimentos da área audiovisual, será necessário preparar o conteúdo de forma a auxiliar na equiparação de conhecimentos entre os participantes. Além de que os estudantes poderão ser de cursos e turmas diferentes, tendo cursado mais ou menos disciplinas que auxiliariam na compreensão e evolução do minicurso a ser ministrado.

9. **Em quais dos itens abaixo você já detém algum conhecimento prévio?** *

Pré-requisitos interessantes (não limitantes para participação no minicurso/pesquisa). Esta pergunta serve para traçar um perfil dos conhecimentos prévios dos interessados. Marque quantos itens desejar.

Marque todas que se aplicam.

- [ ] Conhecimentos no idioma inglês
- [ ] Conhecimentos e habilidades em filmagem (manipulação e configuração de câmeras de vídeo e DSLR's)
- [ ] Conhecimentos relativos a fotografia, direção de fotografia e iluminação cinematográfica
- [ ] Conhecimentos em software de edição não-linear (exemplo: Adobe Premiere®, DaVinci Resolve®, Final Cut Pro®)
- [ ] Conhecimentos em software de composição e pós-produção (exemplos: Adobe After Effects®, Nuke®, Fusion®, DaVinci Resolve®)
- [ ] Conhecimentos em software de edição de imagens (exemplo: Adobe Photoshop®)
- [ ] Conhecimentos em software de computação gráfica (exemplo: Autodesk 3DS Max®, Autodesk Maya®, Autodesk Softimage®, Blender®, Houdini®, LightWave®, Cinema 4D®, Modo®, DaVinci Resolve®)
- [ ] Conhecimentos em composições real x virtual (match moving) em produções audiovisuais
- [ ] Conhecimentos em softwares de camera tracking (exemplos: Boujou®, PFTrack®, SynthEyes®, Nuke®, Fusion®, DaVinci Resolve®)

VIII. The screens of the entire tool (without repetition of items)

On the next pages, a printed version of the prototype (DLO tool) will be made available where it is possible to view all the existing fields for filling in, the illustrations and videos (in illustration / fixed image format) to be able to understand the extent of the tool without the need to use it, filling in the form fields to be able to advance through them.

This example was a test performed with the tool and it was received by mail in the end of the process, where only one element of each was used, to avoid the repetition of collection fields.

For example, the tool allows the use of up to 3 cameras (choosing between two types), one type of each camera was used, the tool allows the collection of up to 4 standard lights and another 4 photometric, totaling 8 lights, only one was used of each type.

VFX Tool for 3ds Max®

Formulários Google <forms-receipts-noreply@google.com>
Sáb, 13/06/2020 23:56
Para: maschio@outlook.com <maschio@outlook.com>

Google Forms

Agradecemos o preenchimento de **VFX Tool for 3ds Max®**

Isto foi o que recebemos de você:

VFX Tool for 3ds Max®

Tool to assist in data collection to integration between real and virtual movies (match moving) with Script Generation. - 3ds Max are registered trademarks or trademarks of Autodesk, Inc., in the USA and other countries. - "This website is independent of Autodesk, Inc., and is not authorized by, endorsed by, sponsored by, affiliated with, or otherwise approved by Autodesk, Inc."

Endereço de e-mail *

maschio@outlook.com

More information about this tool (object learning)

This tool was conceived through a doctoral research for its use in a pedagogical context and can be used as a help in the production of visual effects. If you are a teacher of the audiovisual area and want to have access to the instructional components of this tool (object learning) for use in the context of the classroom, do not forget to visit the website below. https://sites.google.com/campus.fct.unl.pt/digital-media-phd-website-avm **Attention**: Although this tool was developed to support the teaching activity in the audiovisual area, it can be used freely in amateur or professional productions, however, the author is not responsible for any problem, error, damage (direct or indirect), defect, loss of data or system instability during or after its use.

In the following steps, collect the following data from your scene:

- Shot location information - Visual effects information - Camera data collection (limit of 3 cameras at the same time in a scene, choices between legacy or physical type); - Lighting data collection (natural and/or artificial) (limit of 1 natural light in a scene and 8 artificial lights, limited of 4 lights that each type - standard or photometric); - Data relating to reference objects (reference balls for incidence light angle and color of light; reference plane to the place that will receive shadows and reflections from virtual 3d object or character; reference rod for size proportions and shadows); - Reminders about other important types of reference instruments (and images/film to be produced for specific situations) (color checkers, chroma-key references for camera trackers and the creation of photos or film in 360º for reflections). - Data collection for render setup - Presets for 3DS Max File

Alerts

1) While inserting the data do not use the plus sign (+) to indicate that a number is positive. Besides being unnecessary, it will cause errors in the script that will be created. Use the number without any signal to indicate that it is positive, and only use the minus sign (-) when indicating a negative number, no problem in this case. 2) Define your own zero coordinates in the 3 axes (x,y,z) and collecting the data of the spatial position for the objects (cameras, lights, targets, reference objects, etc.) is one of the biggest challenges on the set. In case of inexperience, the exhaustive training of this type of execution becomes imprescidible and vital to that the data collection is done correctly and there are no future problems in the execution of the visual effects.

Would you like to receive previous tips on measuring instruments useful in data collection? *

In this section of tips, you will know some measuring instruments for a better and more accurate data collection.

- (●) Yes, visualize previous tips on measuring instruments.
- ( ) No, proceed to the beginning of data collection.

Measuring instruments helpful in data collection

Know some measuring instruments for help you in the data collection.

Photometer or Light Meter or Exposure Meter

"A light meter is a device used to measure the amount of light. In photography, a light meter is often used to determine the proper exposure for a photograph. Typically a light meter will include either digital or analog electronic circuit, which allows the photographer to determine which shutter speed and f-number should be selected for an optimum exposure, given a certain lighting situation and film speed. Light meters are also used in the fields of cinematography and scenic design, in order to determine the optimum light level for a scene. They are used in the general field of architectural lighting design to verify proper installation and performance of a building lighting system, and in assessing the light levels for growing plants." Text from: https://en.wikipedia.org/wiki/Light_meter

Light Meter


SEKONIC
f/s
29.97
ISO
400
ANG
172.8°
F
5.6 7
2,000lx
AVE /ΔEV
MENU
LITEMASTER PRO
L-478D

Light Meter

Lux Meter

Lux meters are used for measuring brightness in lux, fc or cd/m². Some lux meters are equipped with an internal memory or data logger to record and save measurements. Many lux meters include software for detailed analysis and offer different interfaces for transferring measured data to a computer.

Lux Meter

Color Meter

It is capable of making numerous types of measurements, but their main function is the measurements relative to the color of light, such as the measurement in Kelvin, for example. "Photographers and cinematographers use information provided by these meters to decide what color balancing should be done to make different light sources appear to have the same color temperature. If the user enters the reference color temperature, the meter can calculate the mired difference between the measurement and the reference, enabling the user to choose a corrective color gel or photographic filter with the closest mired factor." Text from: https://en.wikipedia.org/wiki/Colorimetry

Color Meter


SEKONIC
SPECTROMASTER
C-700R-U
Target 5000K
CCT 5229K
⊿uv 0.0033
lux 1011.9lx

Color Meter


SEKONIC
CC
5200
C-500R
PRODIGI COLOR
POWER
PRESET
DISPLAY
MENU
MODE
SET K

Measuring Tapes

A tape measure or measuring tape is a flexible ruler and used to measure distance. It consists of a ribbon of cloth, plastic, fiberglass, or metal strip with linear-measurement markings. It is a common measuring tool. Its design allows for a measure of great length to be easily carried in pocket or toolkit and permits one to measure around curves or corners.

Measuring Tapes

Laser Rangefinder

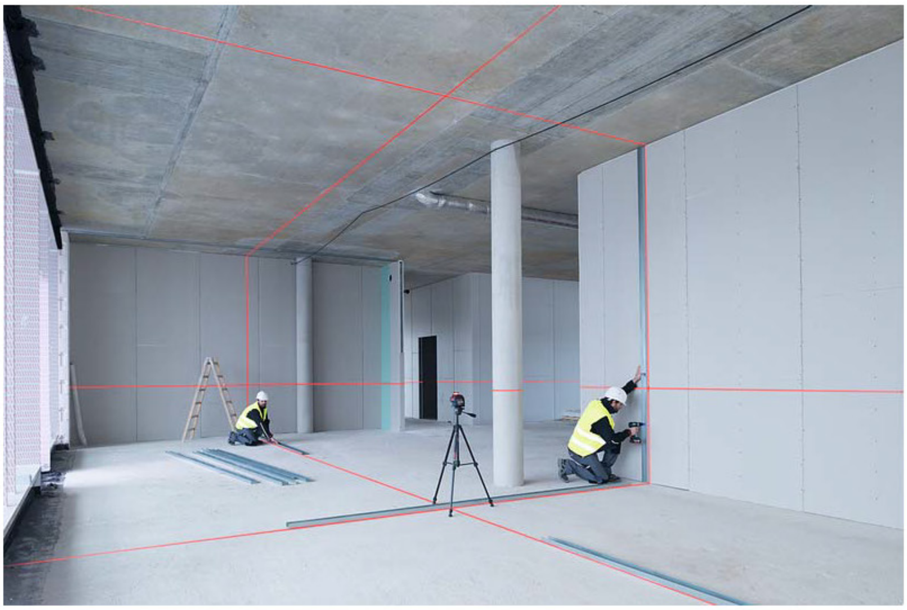
Laser measuring tools typically include the ability to produce some simple calculations, such as the area or volume of a room, as well as switch between imperial and metric units.

Laser Measure Tools

Rotary Laser Level

"A rotary laser level is a more advanced laser level in that it spins the beam of light fast enough to give the effect of a complete 360 degree horizontal or vertical plane, thus illuminating not just a fixed line, but a horizontal plane.[The laser beam projector employs a rotating head with a mirror for sweeping the laser beam about a vertical axis. If the mirror is not self-leveling, it is provided with visually readable level vials and manually adjustable screws for orienting the projector." Text from: https://en.wikipedia.org/wiki/Laser_level A "three-plane leveling alignment laser 360 degree" can be used in association with a Laser Rangefinder to collect the data position from 3 axes (x, y, z). This combination is a more cheap solution than a Total Station, for instance. Other kinds of combination between other tools could be possible and until more cheaper but can be more complex to use, spending more time to collect all the necessary data. So this kind of decision depends on the kind of the use and the time available to the task.

Three Plane Leveling Alignment Laser 360 Degree

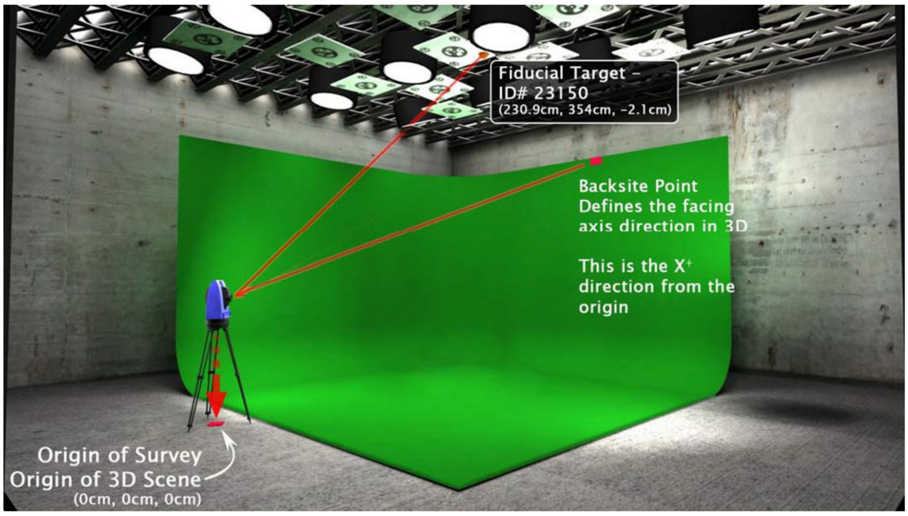


Total Station

"A total station (TS) or total station theodolite (TST) is an electronic/optical instrument used for surveying and building construction. The total station is an electronic theodolite (transit) integrated with an electronic distance measurement (EDM) to read slope distances from the instrument to a particular point, and an onboard computer to collect data and perform advanced coordinate based calculations." Text from: https://en.wikipedia.org/wiki/Total_station "It's not uncommon in virtual productions to use high accuracy measuring tools like LIDAR or Survey guns. The Total Station or Survey Gun functions like a laser tape measure, but with points measured in three axes: Northing, Easting, and Elevation, or XZY." Text from: http://halidefx.com/support/doc/surveying-total-station/surveying-for-vfx/

Total Station

A Total Station in a filming studio



End of measuring instruments helpful in data collection

In the next section begins the data collection for the production of visual effects for the integration between real and virtual images. Remember that measuring instruments for data collection will allow more accurate and effective data collection. Of course, the better the equipment available and the training of the team responsible for collecting the data, faster and precise it will be.

Repeating the alert

Define your own zero coordinates in the 3 axes (x,y,z) and collecting the data of the spatial position for the objects (cameras, lights, targets, reference objects, etc.) is one of the biggest challenges on the set. In case of inexperience, the exhaustive training of this type of execution becomes imprescidible and vital to that the data collection is done correctly and there are no future problems in the execution of the visual effects.

Shot Location Information

Some fields are not required.

User Name / VFX Supervisor *

Maschio

Department

VFX

Production Title

Test Man

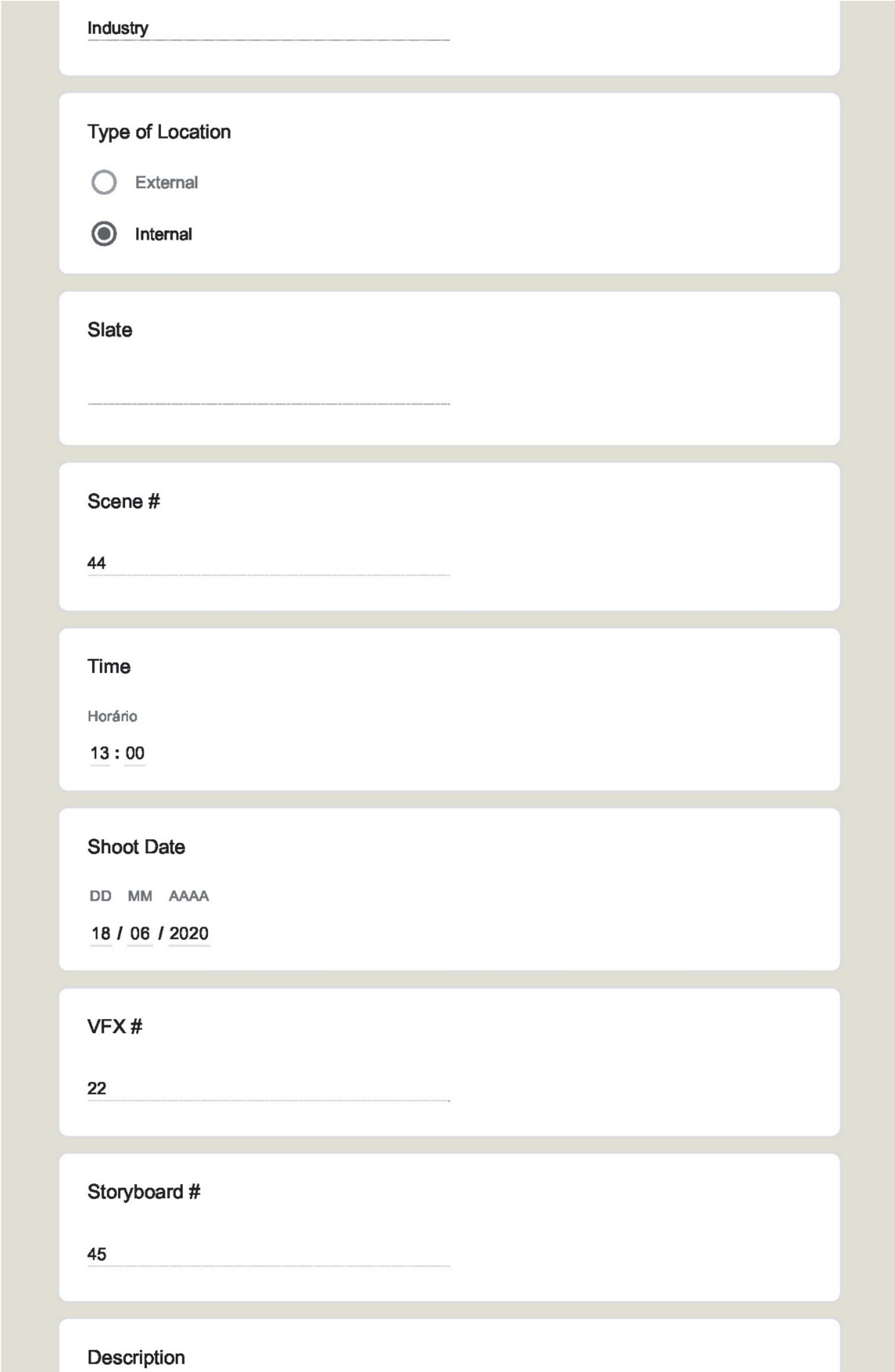
Scene / Sequence Name *

Destruction

Set

School

Shoot Location



Industry

Type of Location

- External
- Internal

Slate

Scene #

44

Time

Horário

13 : 00

Shoot Date

DD MM AAAA

18 / 06 / 2020

VFX #

22

Storyboard #

45

Description

Description of the Effect or Scene ?

End of data collection for shot location information

Visual Effects Information

No field in this section is required.

VFX 2D

Annotations.

VFX 3D

Annotations.

Annotations

Other Media Information

- [x] Photos
- [ ] Video
- [x] Diagrams
- [ ] HDRI
- [x] Motion Control Data
- [ ] Survey
- [ ] Lidar
- [ ] Notes

HDRI Film Rolls

44, 33, 56

End of data collection for visual effects information

Camera Data Collection

There are two kinds of cameras in 3ds Max: - Physical Cameras integrate framing the scene with exposure control and other effects that model real-world cameras; - Legacy Cameras have a simpler interface with fewer controls.

Camera 01 *

Select the camera type.

- (●) Legacy Camera (Free or Target).
- ( ) Physical Camera (Free or Target).

Camera data 1 (Legacy)

Legacy cameras are the camera types provided by 3ds Max in releases prior to 3ds Max 2017. Some fields are not required.

Camera Name *

Warning: Do not repeat the name of the cameras to avoid problems in running the script later. The name is limited to 30 characters with spaces.

Nikon T2

Camera Motion *

Image static or moving? Any movement should be considered, such as lens (zoom), nodal pan, dolly, travelin, crane, etc.

- (●) Lockoff
- ( ) Pan / Tilt
- ( ) Dolly
- ( ) Motion Control System
- ( ) Crane
- ( ) Camera Stabilizer (Steadycam)
- ( )

Hand-held

Camera Tracker

Alert
- For moving images, consider the start moment to fill the data.

Camera Roll

Film Stock

Film Format

Camera Body

Camera Head

Camera Mount

Lens Filters

Display Aspect Ratio (DAR) *

Also known as image aspect ratio and picture aspect ratio. Some examples: 4:3 (1.33:1); 16:9 (1.78:1); 21:9 (2.33:1); 256:135 (1.9:1).

16:9

Frame Rate (FPS) *

30

FOV

Determines how wide an area the camera views (field of view). When FOV Direction is horizontal (the default), the FOV parameter directly sets the arc of the camera's horizon, measured in degrees. You can also set the FOV Direction to measure FOV vertically or diagonally inside the software, not here to script creation.

Field of View (FOV) *

Input the data "Angle of view" (deg) in horizontal direction degrees, not in vertically or diagonally degrees, and also not in (mm) "Lens Focal Length". If you don't know how to convert/calculate from mm to horizontal degrees, look this option: https://www.scantips.com/lights/fieldofview.html#top

55

Clipping Planes Group

Sets options to define clipping planes. In viewports, clipping planes are displayed as red rectangles (with diagonals) within the camera's cone.

Clip Manually *

When Clip Manually is off, the camera ignores the location of the Near and Far clipping planes, and their controls are unavailable. The camera renders all geometry within its field of view. (off - default).

off

Near Clip and Far Clip

Sets near and far planes. Objects closer than the near clipping plane or farther than the far clipping plane are invisible to the camera. It is necessary that "Clip Manually" be turned on so that the inserted data is used.

Near Clip *

Set the Near Clip value to position the near clipping plane. Objects closer to the camera than the Near distance are not visible to the camera and aren't rendered. Use the measurement in inches (1 in - default).

1

Far Clip *

Set the Far Clip value to position the far clipping plane. Objects farther from the camera than the Far distance are not visible to the camera and aren't rendered. Use the measurement in inches (1000 in - default).

1000

Environment Ranges Group

Near Range and Far Range Set the near and far range limits for the atmospheric effects set on the Environment panel. Objects between the two limits fade between the Far % and Near % values.

Show Ranges *

To see the environment ranges in viewports. The environment range displays as two planes. The plane closest to the camera is the near range and the one farthest from the camera is the far range. (off - default).

off

Near Range *

Use the measurement in inches (0 in - default).

0

Far Range *

Use the measurement in inches (1000 in - default).

1000

Show Cone and Show Horizon

Show Cone *

The camera's field-of-view cone appears outlined in light blue, even with the camera unselected. Note: A camera's cone is always visible while the camera object is selected, regardless of the Show Cone setting. (off - default).

off

Show Horizon *

A dark gray line appears at the level of the horizon in the camera's viewport. Note: The horizon line might not be visible if the horizon is beyond the camera's field of view, or if the camera is tilted very high or low. (off - default)

off

Camera Effects

Multi-Pass Effect *

These controls let you assign a depth-of-field or motion blur effect to the camera. When generated by a camera, these effects generate blurring by rendering the scene in multiple passes, with offsets. They increase rendering time (off - default).

off

Render Effects Per Pass *

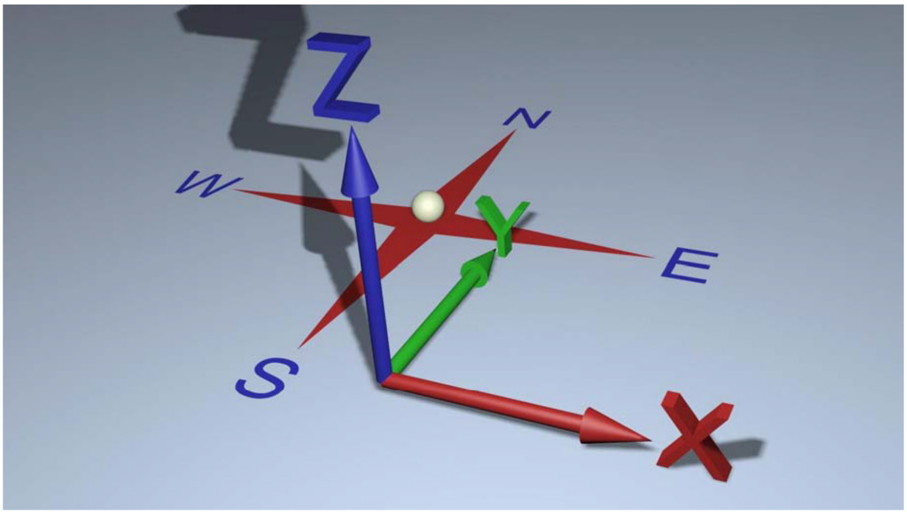
When on, applies rendering effects, if any are assigned, to each pass of the multi-pass effect (depth of field or motion blur). When off, applies rendering effects only after the passes that generate the multi-pass effect. Default=off.Turning off Render Effects Per Pass can improve the render time for multi-pass effects (off - default).

off

Camera Position

Remember that it is you that define in the real world where it will consider your zero points of three axes and the spatial localization (compass). See the image below as a reference.

The position of the three axes on the 3d software with the compass.



Camera Spatial Position - X Axis *

Use the measurement in inches.

0

Camera Spatial Position - Y Axis *

Use the measurement in inches.

0

Camera Spatial Position - Z Axis *

Use the measurement in inches.

0

Kinds of Legacy Camera

There are two kinds of legacy camera: A Target camera views the area around a target object. When you create a target camera, you see a two-part icon representing the camera and its target (which displays as a small box). The camera and the camera target can be animated independently, so target cameras are easier to use when the camera does not move along a path. A Free camera views the area in the direction the camera is aimed. When you create a free camera, you see a single icon representing the camera and its field of view. The camera icon appears the same as a target camera icon, but there is no separate target icon to animate. Free cameras are easier to use when the camera's position is animated along a path.

Kind of Camera *

- (selected) Free Camera
- Target Camera

Target Position

Remember that it is you that define in the real world where it will consider your zero points of three axes and the spatial localization (compass). ATTENTION: If you selected Free Camera before and not Target Camera this data will not be used. In this case, fill with any value just so the fields are not empty.

Target Spatial Position - X Axis *

Use the measurement in inches.

0

Target Spatial Position - Y Axis *

Use the measurement in inches.

0

Target Spatial Position - Z Axis *

Use the measurement in inches.

0

Target Distance

For a Free camera, sets a point to use as an invisible target.

Target Distance *

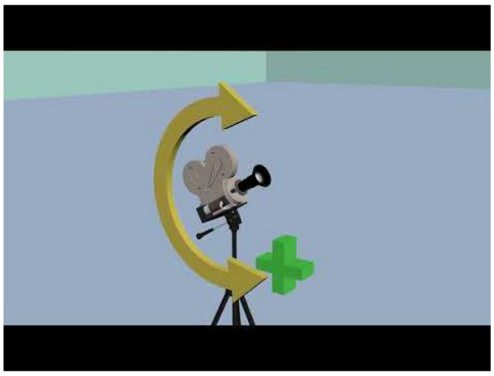
Use the measurement in inches (131,095 in - default).

131.095

Camera Angles

If you are using a target camera, the values for "front tilt angle" and "lateral rotation angle (panoramic)" will not be used because by informing the target position the camera will automatically point to that location. The only data that can be used is the "Side Tilt Angle (Dutch Angle)".

Front Tilt Angle



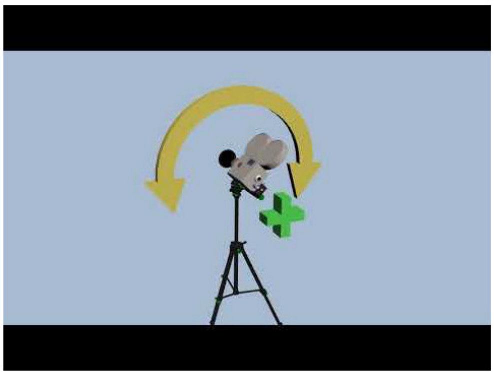
http://youtube.com/watch?v=HQdyp23H_6k

Front Tilt Angle *

In degrees (positive up and negative down). If you are using a target camera, this data will not be used. Put any value only to don't left blank.

0

Side Tilt Angle (Dutch Angle)



http://youtube.com/watch?v=szoAwIOvLuY

Side Tilt Angle (Dutch Angle) *

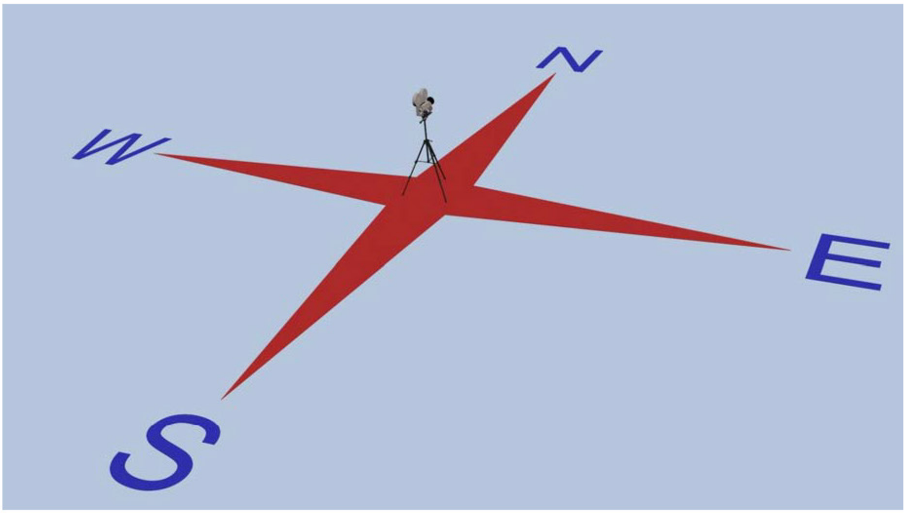
In degrees (positive to the right {clockwise} and negative to the left {anticlockwise}) (0 degrees - default).

0

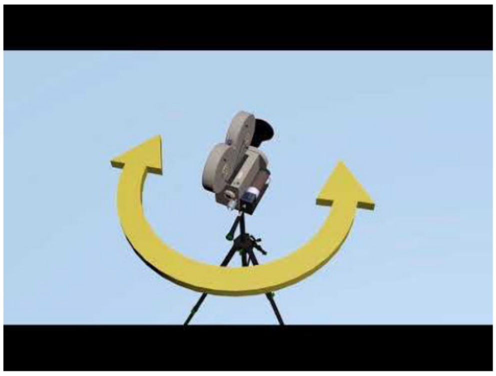
Alert for the Lateral Rotation Angle (Panoramic)

The camera is created by default pointing to the north, this is the reference for the insertion of the values, mainly to Lateral Rotation Angle (Panoramic). For instance, if the camera it is in the zero position and it was pointed to the south, the angle to be inputted will be 180 or -180 degrees.

The camera initial position it is pointed to the north.



Lateral Rotation Angle (Panoramic)



http://youtube.com/watch?v=19TB9eMofo4

Lateral Rotation Angle (Panoramic) *

In degrees (positive to the left and negative to the right). If you are using a target camera, this data will not be used. Put any value only to don't left blank.

0

End of data collection for camera 01

Add another camera in the same scene? *

- ○ No, this scene is being filmed with only one camera, proceed to the other elements.
- ○ Yes, Camera 02 - Legacy Type (Free or Target).
- ◉ Yes, Camera 02 - Physical Type (Free or Target).

Camera data 2 (Physical)

The Physical Camera integrates framing the scene with exposure control and other effects. Physical Camera is the best camera type to use for photorealistic, physically-based rendering. The level of support for Physical Camera features depends on the renderer you are using. The physical camera also can be set as free or target camera with all your resources. Some fields are not required.

Camera Name *

Warning: Do not repeat the name of the cameras to avoid problems in running the script later. The name is limited to 30 characters with spaces.

Cannon FS

Camera Motion *

Image static or moving? Any movement should be considered, such as lens (zoom), nodal pan, dolly, travelin, crane, etc.

- ○ Lockoff
- ◉ Pan / Tilt
- ○ Dolly
- ○ Motion Control System
- ○ Crane
- ○ Camera Stabilizer (Steadycam)
- ○ Hand-held
- ○ Camera Tracker

Alert

- For moving images, consider the start moment to fill the data.

Camera Rool

Film Stock

Film Format

Camera Body

Camera Head

Camera Mount

Lens Filters

Display Aspect Ratio (DAR) *

Also known as image aspect ratio and picture aspect ratio. Some examples: 4:3 (1.33:1); 16:9 (1.78:1); 21:9 (2.33:1); 256:135 (1.9:1).

4:3

Frame Rate (FPS) *

60

Film / Sensor Width (mm)

Chooses the model of film or charge-coupled sensor. The choices are 35mm (Full Frame) film (the default), and a variety of industry-standard sensor settings. Each setting has its default Width value. The Custom choice is for choosing an arbitrary Width.

A preset film or customize *

Choose between a preset or the last option to insert the data manually (custom option).

- (●) 35mm - (Full Frame) - Width 36.0mm
- ( ) APS-C (Canon) - Width 22.3mm
- ( ) APS-C (Nikon, Sony, and so on) - Width 23.7mm
- ( ) APS-H (Canon) - Width 27.9mm
- ( ) Four Thirds - Width 17.3mm
- ( ) Custom - Custom Width - input data below

Film / Sensor Width (mm) *

Manually adjust the width of the frame. 1- To use this feature it is mandatory to select the last option in the previous question. 2- If you have chosen a preset, enter any number so that the question is not left blank (the data will not be considered).

0

Exposure Value

To calculate the exposure value you need to know 3 camera setup information: shutter speed, f / stop, and iso (asa). If you need, you can use these two sites suggested below to calculate the "EV": -> https://www.scantips.com/lights/evchart.html -> https://rechneronline.de/exposure/

Exposure Value *

Sets a single Exposure Value setting that corresponds to a combination of the three Photographic Exposure values. Each increment or decrement in the EV value corresponds to halving or doubling, respectively, the effective exposure, as expressed in the resultant change in the Shutter Speed value. Thus, higher values yield darker images, and lower values yield brighter images. (6 EV - default).

6

FOV

Determines how wide an area the camera views (field of view). When FOV Direction is horizontal (the default), the FOV parameter directly sets the arc of the camera's horizon, measured in degrees. You can also set the FOV Direction to measure FOV vertically or diagonally inside the software, not here to script creation.

Field of View (FOV) *

Input the data "Angle of view" (deg) in horizontal direction degrees, not in vertically or diagonally degrees, and also not in (mm) "Lens Focal Length". If you don't know how to convert/calculate from mm to horizontal degrees, look this option: https://www.scantips.com/lights/fieldofview.html#top

73

Other Settings

Focal Length (mm) *

Sets the focal length of the lens. (40.0 mm - default).

40

Aperture - "f-number" or "f-stop" *

Sets the aperture as an f-number, or "f-stop." This value affects both exposure and depth-of-field. The lower the f-number, the wider the aperture and the narrower the depth of field. (8 - default).

8

Zoom Factor *

Zooms the lens in or out without changing the camera position. Zoom provides a way to crop the rendered image without altering any other camera effects. Increasing this value above 1.0 has the effect of narrowing the Field Of View and zooming in. Decreasing the value below 1.0 has the effect of widening the Field Of View and thus zooming out. (1 - default).

1

Depht of Field *

When on, the camera generates blurring at distances not equal to the focus distance. The strength of the depth-of-field effect is based on the Aperture setting. (off - default).

off

Motion Blur Enabled *

When on, the camera generates motion blur. (off - default).

off

Show Camera Cone *

When the camera's cone is displayed.

When Selected (default)

Horizon On *

When on, the horizon is displayed as a horizontal line in camera viewports (assuming the camera frame includes the horizon). (off - default).

off

White Balance

Adjusts the color balance.

Presets or Kelvin to White Balance *

Sets the color balance in terms of a standard light source (preset) or in terms of color temperature, measured in degrees Kelvin (last option).

- (●) Daylight (6500K)
- ( ) Sunlight (5200K)
- ( ) Shade (7000K)
- ( ) Overcast (6000K)
- ( ) Incandescent (3200K)
- ( ) Fluorescent (4000K)
- ( ) CIE A - Incandescent / Tungsten

- CIE D50 - Horizon Light
- CIE D55 - Morning/Afternoon Daylight
- CIE D65 - Noon Daylight
- CIE D75 - Northern Daylight
- CIE F1 - Fluorescent Daylight
- CIE F2 - Fluorescent Cool White
- CIE F3 - Fluorescent White
- CIE F4 - Fluorescent Warm White
- CIE F5 - Fluorescent Daylight
- CIE F6 - Fluorescent Light White
- CIE F7 - Fluorescent D65 Simulator
- CIE F8 - Fluorescent D60 Simulator
- CIE F9 - Fluorescent Cool White Deluxe
- CIE F10 - Fluorescent TL-85
- CIE F11 - Fluorescent TL-84
- CIE F12 - Fluorescent TL-83
- Halogen Warn (2800K)
- Halogen (3200K)
- Halogen Cool (4000K)
- HID Ceramic Metal Halide Warm (3000K)
- HID Ceramic Metal Halide Cool (4200K)
- HID Quartz Metal Halide Warm (3200K)
- HID Quartz Metal Halide (4000K)
- HID Quartz Metal Halide Cool (6000K)
- HID Mercury (3900K)
- HID Phosphor Mercury (4000K)

- HID Xenon (6000K)
- High Pressure Sodium (2100K)
- Low Pressure Sodium (1800K)
- I prefer to insert Kelvin measure below

Kelvin *

Sets the color balance in terms of color temperature, measured in degrees Kelvin. 1- To use this feature it is mandatory to select the last option in the previous question. 2- If you have chosen a preset, enter any number so that the question is not left blank (the data will not be considered).

0

Clipping Planes Group

In viewports, clipping planes are displayed as red grids within the camera's cone. (off - default).

Clip *

(off - default).

off

Near Clip and Far Clip

Sets near and far planes. Objects closer than the near clipping plane or farther than the far clipping plane are invisible to the camera.

Near Clip *

Use the measurement in inches (0 in - default).

0

Far Clip *

Use the measurement in inches (39370.1 in - default).

39370.1

Environment Ranges Group

Near Range and Far Range Determine the near and far range limits for the atmospheric effects set on the Environment panel. Objects between the two limits fade between the Far and Near values. These values are expressed in scene units. By default, they encompass the extents of the scene.

Near Range *

Use the measurement in inches (0 in - default).

0

Far Range *

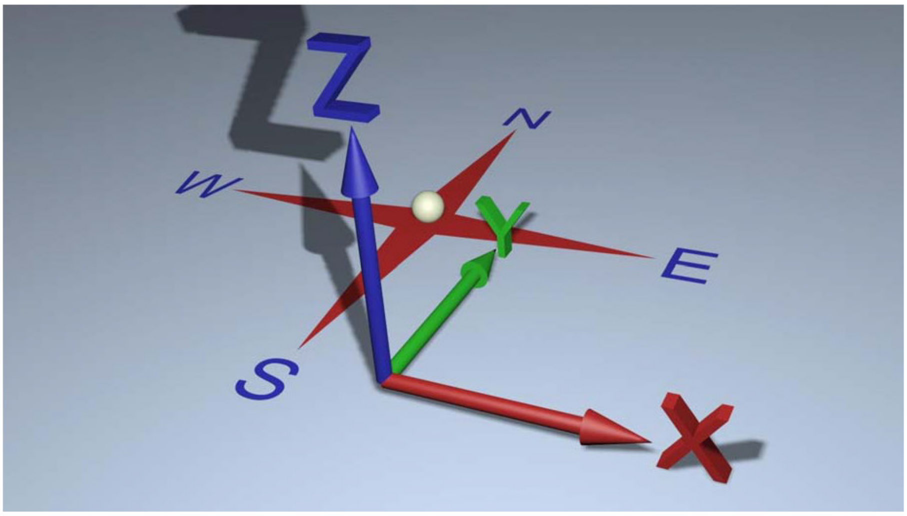
Use the measurement in inches (39370.1 in - default).

39370.1

Camera Spatial Position

Remember that it is you that define in the real world where it will consider your zero points of three axes and the spatial localization (compass). See the image below as a reference.

The position of the three axes on the 3d software with the compass.



Camera Spatial Position - X Axis *

Use the measurement in inches.

1

Camera Spatial Position - Y Axis *

Use the measurement in inches.

1

Camera Spatial Position - Z Axis *

Use the measurement in inches.

1

Target

When on, the camera includes a target object, and behaves like a Target Camera: You can aim the camera by moving the target. When off, the camera behaves like a Free Camera: You aim it by transforming the camera object itself.

Target *

(on - default).

on

Target Position

Remember that it is you that define in the real world where it will consider your zero points of three axes and the spatial localization (compass). ATTENTION: If you selected the target as "off" before, this data will not be used. In this case, fill with any value just so the fields are not empty.

Target Spatial Position - X Axis *

Use the measurement in inches.

15

Target Spatial Position - Y Axis *

Use the measurement in inches.

15

Target Spatial Position - Z Axis *

Use the measurement in inches.

15

Target Distance *

Sets the distance between the target and the focal plane. The Target Distance affects focusing, depth-of-field, and so on. Use the measurement in inches (196.85 in - default).

197

Focus Controls

The focus plane appears in viewports as a transparent rectangle, bounded by the dimensions of the camera's view.

Use Target Distance or Customize *

(use target distance - default).

Uses the Target Distance as the focus distance

Focus Distance *

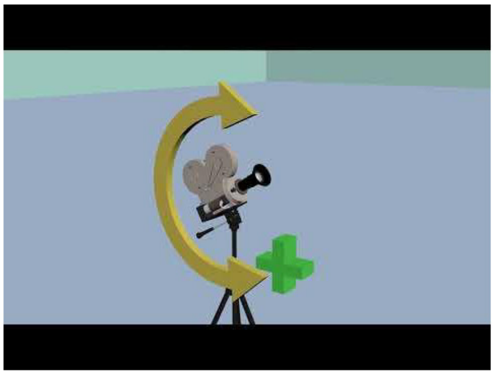
1- If you have chosen uses a target distance, enter any number so that the question is not left blank (the data will not be considered). 2- If Custom was chosen in the last question, set the focus distance. Use the measurement in inches.

13

Camera Angles

If you are using a target camera, the values for "front tilt angle" and "lateral rotation angle (panoramic)" will not be used because by informing the target position the camera will automatically point to that location. The only data that can be used is the "Side Tilt Angle (Dutch Angle)".

Front Tilt Angle



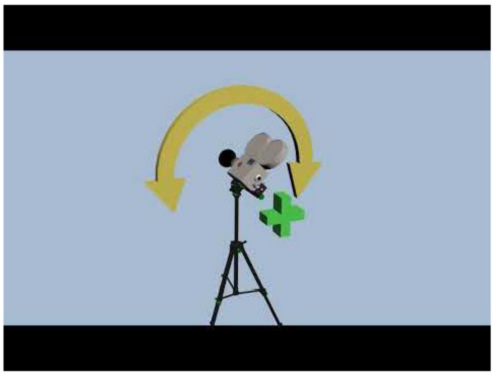
http://youtube.com/watch?v=HQdyp23H_6k

Front Tilt Angle *

In degrees (positive up and negative down). If you are using a target camera, this data will not be used. Put any value only to don't left blank.

0

Side Tilt Angle (Dutch Angle)



http://youtube.com/watch?v=szoAwlOvLuY

Side Tilt Angle (Dutch Angle) *

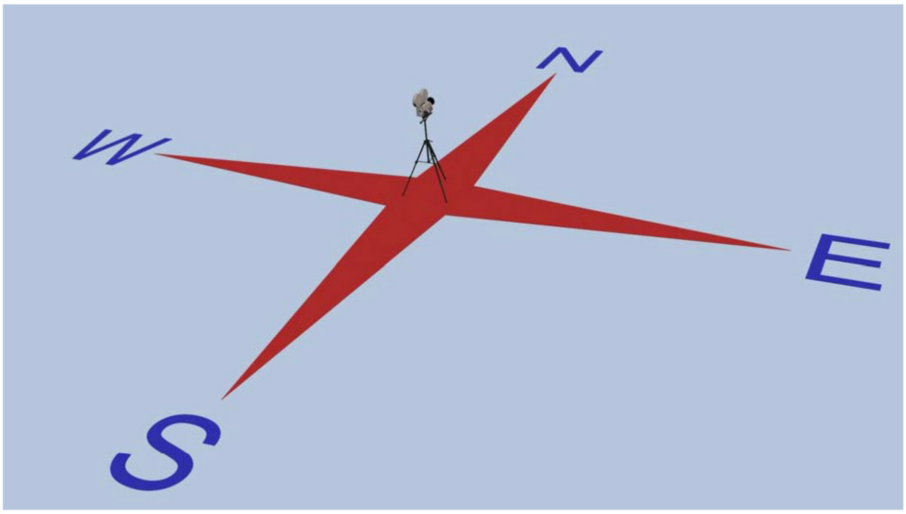
In degrees (positive to the right {clockwise} and negative to the left {anticlockwise}) (0 degrees - default).

0

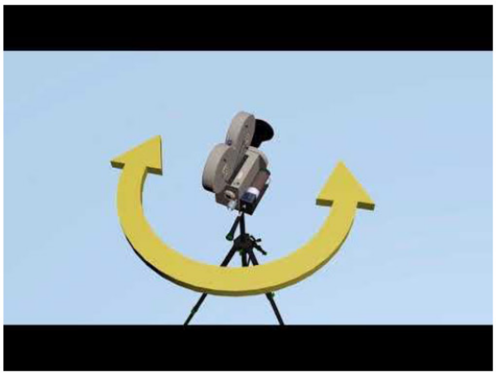
Alert for the Lateral Rotation Angle (Panoramic)

The camera is created by default pointing to the north, this is the reference for the insertion of the values, mainly to Lateral Rotation Angle (Panoramic). For instance, if the camera it is in the zero position and it was pointed to the south, the angle to be inputted will be 180 or -180 degrees.

The camera initial position it is pointed to the north.



Lateral Rotation Angle (Panoramic)



http://youtube.com/watch?v=19TB9eMofo4

Lateral Rotation Angle (Panoramic) *

In degrees (positive to the left and negative to the right). If you are using a target camera, this data will not be used. Put any value only to don't left blank.

0

End of data collection for camera 02

Add another camera in the same scene? *

- (selected) No, this scene is being filmed with only two cameras, proceed to the other elements.
- Yes, Camera 03 - Legacy Type (Free or Target).
- Yes, Camera 03 - Physical Type (Free or Target).

Lights

The lights are divided into the following categories: - Natural Light (it is possible to collect data that only 1 light of this type). - Standard Lights (it is possible to collect data of up to 4 lights of this type); - Photometric Lights (it is possible to collect data of up to 4 lights of this type). The types of lights within each category are as follows. Natural Light: - Day Light. Standard Lights: - Directional Light; - Free Spot; - Omni Light; - Target Spot; - Target Directional Light. Photometric Lights (Free or Target): - Free Point - Free Linear - Free Area - Free Disc - Free Sphere - Free Cylinder - Target Point - Target Linear - Target Area - Target Disc - Target Sphere - Target Cylinder

Attention, data collection follows the order above

For example, it is not possible first to add photometric lights and after add standard or natural lights.

Initiate lighting data collection

Lighting Data Collection

Natural Light *

Do you want to collect natural light data? You will not be able to do it later.

- (selected) Yes, I want to collect natural light data.
- No, I want to collect data only from artificial lights.
- No, I do not want to collect data of any kind of light.

Natural Light

Lighting systems simulate sunlight based on location and time of day, month, and year. This makes it easier to set up than if you had to simulate sunlight using standard or photorealistic lights. The Sunlight and Daylight systems use light in a system that follows the geographically correct angle and movement of the sun over the earth at a given location. You can choose the location, date, time, and compass orientation. You can also animate the date and time. In addition, you can animate Latitude, Longitude, North Direction, and Orbital Scale. Note 01: There is the possibility of downloading weather data through sites that record the data collected by the meteorological stations around the world. Through this type of file (Weather File) with the EPW extension, it is possible to import the meteorological information of the day of the recording of the scene, with varied data like date, time and place (latitude, longitude, north direction), among others. Note 02: The Sunlight and Daylight lighting systems do not allow the insertion of data through Script, for this reason, the data collected must be inserted manually into the 3d animation software. The Script generated although not transporting the data to the system will create a Daylight system and will inform the data (at the end of its execution) for later insertion of the data. The user can also access all data collected through the copy of the completed form that will receive by email at the end of the use of the tool.

Hours / Mins *

Horário

14 : 00

Month / Day / Year *

DD MM AAAA

25 / 06 / 2020

Time Zone *

Time zones range from –12 to 12. If you're uncertain about a time zone, you can look them up on this website for example (https://www.timeanddate.com/time/map/).

6

Daylight Savings Time *

When on, calculates daylight savings by adjusting azimuth and altitude during the summer months.

off

Latitude *

The latitude is the angle between the plane of the equator and the reference surface.. This distance is measured in degrees and can vary between -90º and 90º for North (N) (+) or for South (S) (-).

35

Longitude *

The longitude is the distance to the Greenwich meridian measured along the Equator. This distance is measured in degrees and can vary between -180º and 180º for North (N) (+) or for South (S) (-).

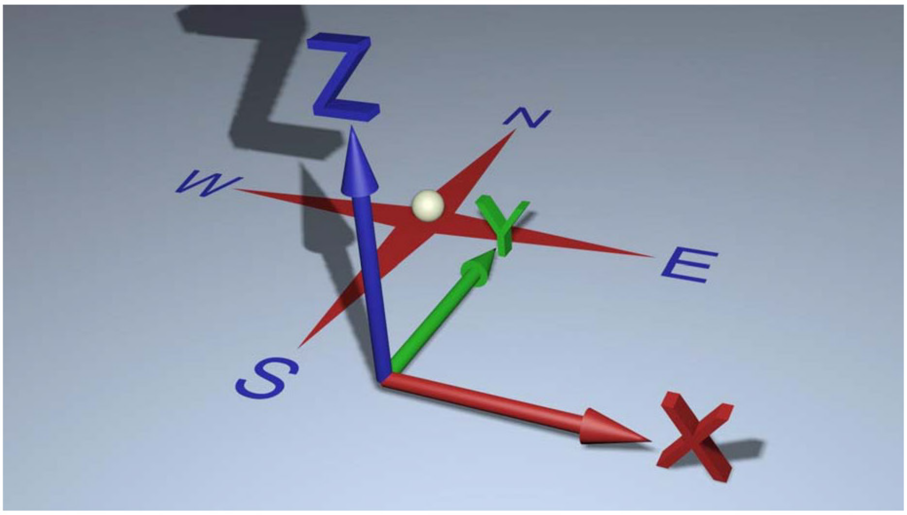
-110

North Direction *

Sets the rotational direction of the compass rose in the scene. This is the geographical orientation of the compass rose. By default, north is 0 and points along the positive Y axis of the ground plane. Positive X (East) is 90 degrees. Adjust the North Direction to correspond to your site. Accuracy of the system depends on this correspondence. The measured in degrees and can vary between 0° and 359.99° (0 degrees - default).

45

The position of the three axes on the 3d software with the compass.



Sun and Sky definitions

Define the sun and sky classes to be used to create a Daylight system. mr Sun and mr Sky (The default.) The mr Sun and mr Sky lights are photometric lights, and are specifically intended for use with the mental ray Sun And Sky solution, and the mental ray renderer. When you use mr Sun and mr Sky, it is appropriate to use an mr Physical Sky environment map, Final Gather and an mr Photographic exposure control. IES Sun and IES Sky The IES Sun and IES Sky lights are also photometric lights. It is appropriate to use them if you are creating a rendering that uses a radiosity solution with exposure control, in conjunction with the scanline renderer. Standard light and Skylight The Standard light and Skylight are not photometric. It is appropriate to use them only if your scene uses standard lighting (the Sunlight system with its Directional light works for this, too), or if you are using light tracing.

Possible classes for Sun *

(mr_Sun - default).

mr_Sun ▾

Possible classes for Sky *

(mr_Sky - default).

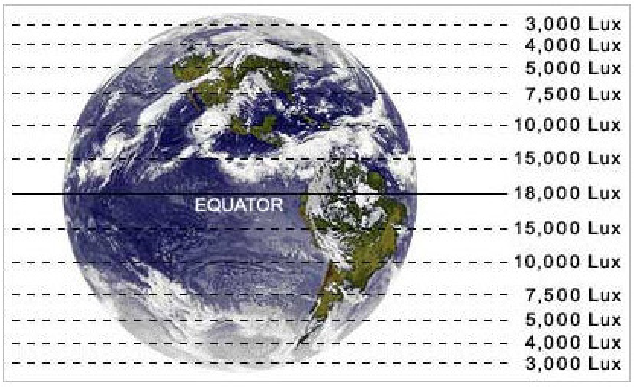
mr_Sky ▾

Diffuse and direct illuminance

If you select the class for Sky "mr_Sky" you can select the Sky Model set. Among the 3 possible options are "Perez All-Weather Sky Model" and "CIE Sky Model" that accept direct and diffused illuminance data. The third option "Haze-Driven Sky Model" allows a configuration through possible values ranging from 0.0 to 15.0, but they are not values measurable by a measurement instrument like the lux meter.

Diffuse Horizontal Illuminance *

The illuminance of the sky measured by a luminance meter placed horizontally, outdoors, excluding the contribution from the sun (10000.0 lx. - default). Note: If you chose American units as the active lighting units, the illuminance values appear as footcandles (fc) rather than lux (lx).



10000

Direct Normal Illuminance *

The illuminance of the sun measured by a luminance meter aimed directly at the sun (10000.0 lx. - default). Note: If you chose American units as the active lighting units, the illuminance values appear as footcandles (fc) rather than lux (lx).

10000

Sky coverage for all types of models

Sky Coverage *

For IES_Sky classes.

Clear

Sky Coverage *

For mr_Sky classes and CIE Sky Model.

Clear Sky ▾

End of data collection for natural light

Add artificial lights? *

- (●) Yes, I want to collect data from artificial lights.
- ( ) No, there are no artificial lights in the scene, just natural light, proceed to the other elements.

Artificial Lights

As previously stated, exist one order to collect the data. By order, you need to collect the light data from the standard category and then collect photometric category lights. You can not first collect the photometric and then the standard ones. You can collect data from only one light category if you prefer. Standard type lights are simple to use, photometric type lights are more complex but provide a model more like real-world lighting (they are often used in conjunction with the radiosity mechanism - global illumination).

Add Light from the standard category? *

You will not be able to collect light data from this category later.

- (●) Yes, add standard light.
- ( ) No, go for data collection of photometric lights category.
- ( ) No, there are no more lights in the scene, continue to collect data from other elements.

Standard Light 01

Standard lights are computer-based objects that simulate lights such as household or office lamps, the light instruments used in stage and film work, and the sun itself. Different kinds of light objects cast light in different ways, simulating different kinds of real-world light sources. Unlike photometric lights, standard lights do not have physically-based intensity values. Target Spotlight A spotlight casts a focused beam of light like a flashlight, a follow spot in a theater, or a headlight. A target spotlight uses a movable target object to aim the light. Free Spotlight Unlike a targeted spotlight, a Free Spot has no target object. You can move and rotate the free spot to aim it in any direction. Target Directional Light Directional lights cast parallel light rays in a single direction, as the sun does (for all practical purposes) at the surface of the earth. Directional lights are primarily used to simulate sunlight. You can adjust the color of the light and position and rotate the light in 3D space. A target directional light uses a movable target object to aim the light. Free Directional Light Unlike a targeted directional light, a Free Directional Light has no target object. You can move and rotate the directional light to aim it in any direction. Omni Light An Omni light casts rays in all directions from a single source. Omni lights are useful for adding "fill lighting" to your scene, or simulating point source lights.

What the type of standard light? *

Non-target lights will be created through the script pointing to the ground, unlike target lights that will have the slope generated by the positioning difference between the position of the light and its target.

- ○ Target Spotlight
- ○ Free Spotlight
- ○ Target Directional Light
- ○ Free Directional Light
- ◉ Omni Light

Name of light *

Warning: Do not repeat the name of the lights to avoid problems in running the script later. The name is limited to 30 characters with spaces.

Luz simples

RGB color

The red, green, and blue components of the light's color. You can use this option if you want to use a color disc to inform approximately the color of the light (unlike the photometric lights that allow you to collect an accurate color data in Kelvin temperature). Following is a website that allows you to get the RGB data from a color disk, there are several with the same functionalities (https://www.rapidtables.com/web/color/color-wheel.html).

Red color *

Values range from 0 to 255 (the default for white light is 255).

255

Green color *

Values range from 0 to 255 (the default for white light is 255).

255

Blue color *

Values range from 0 to 255 (the default for white light is 255).

255

Multiplier *

Amplifies the power of the light (1 - default).

1

Cast Shadows *

When on, the light will cast shadows on objects (off - default).

off

Shadow Multiplier *

Controls the density of the shadow. Lower values make the shadow more transparent (1 - default).

1

Light Affects Shadow *

When on, blends the light's color with the shadow color (or shadow colors, if the shadow is mapped) (off - default).

off

Attention:

The following data is not used for Omni type lights. If this is the case enter any value in the fields only so as not to leave them blank.

Show Cone *

Turns display of the cone on or off. Set cone visible or not in viewport when unselected. (off - default).

off

Cone Shape *

The shape of the falloff and hotspot areas: (circle - default).

Circle

Aspect Ratio *

The aspect ratio for the rectangular light beam (1 - default).

1

Hotspot / Beam *

The angle of a light's cone. The Hotspot value is measured in degrees (43 - default).

43

Falloff / Field *

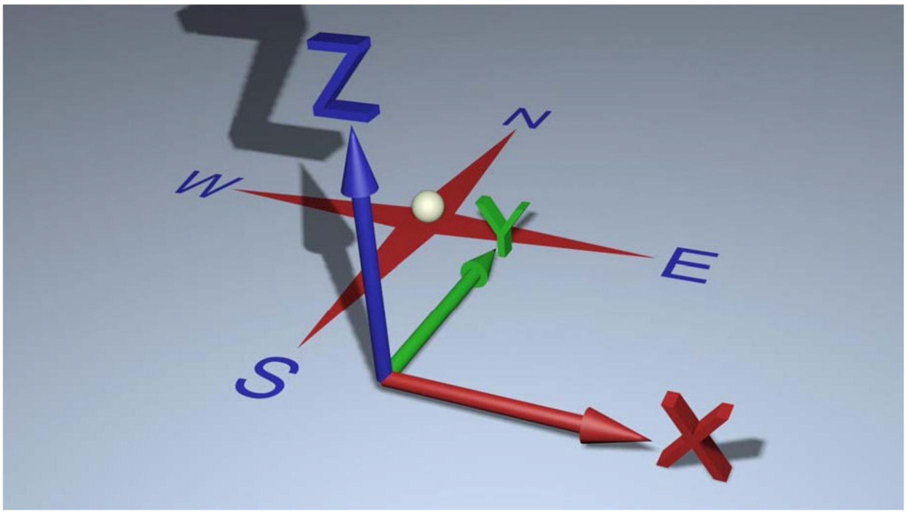
The angle of a light's falloff. The Falloff value is measured in degrees (45 - default).

45

Spatial Position of Light

Compulsory and indispensable data.

The position of the three axes on the 3d software with the compass.



Spatial Position of Light - X Axis *

Use the measurement in inches.

50

Spatial Position of Light - Y Axis *

Use the measurement in inches.

50

Spatial Position of Light - Z Axis *

Use the measurement in inches.

50

Spatial Position of the Target of Light

Compulsory and indispensable data only for two kinds of Lights: Target Spot and Target Directional Light. If you are not using one of it, enter any value in the fields, only so as not to leave them blank.

Spatial Position of the Target of Light - X Axis *

Use the measurement in inches.

80

Spatial Position of the Target of Light - Y Axis *

Use the measurement in inches.

80

Spatial Position of the Target of Light - Z Axis *

Use the measurement in inches.

80

End of data collection for standard light 01

Add standard light 02? *

You will not be able to add new standard category lights later.

- ◯ Yes, collect data for a new standard light.
- ◉ No, go for the data collection of photometric lights.
- ◯ No, there are no more lights in the scene, continue to collect data from other elements.

Photometric Light 01

What the type of photometric light? *

Non-target lights will be created through the script pointing to the ground, unlike target lights that will have the slope generated by the positioning difference between the position of the light and its target.

- ◯ Free_Point
- ◉ Free_Linear
- ◯ Free_Area
- ◯ Free_Disc
- ◯ Free_Sphere
- ◯ Free_Cylinder
- ◯ Target_Point
- ◯ Target_Linear
- ◯ Target_Area
- ◯ Target_Disc
- ◯ Target_Sphere
- ◯ Target_Cylinder

Name of light *

Warning: Do not repeat the name of the lights to avoid problems in running the script later. The name is limited to 30 characters with spaces.

Linear Photometric Light

Multiplier *

Set the Dimming multiplier value in percent (100 - default).

100

Unit of measure of luminous intensity

There are several types of units of measure of luminosity, the three most used are Lumens, Candela and Lux. In this tool the unit used is Lumens, so if you are performing the measurement using another unit, you can convert it using, for example, the following suggested sites below. Lux to lumens -> (https://www.rapidtables.com/calc/light/lux-to-lumen-calculator.html) Candela to lumens -> (https://www.rapidtables.com/calc/light/candela-to-lumen-calculator.html) If you do not know what the "apex angle in degrees" to convert directly Candela to Lumens you can convert Candela to Lux and then Lux to Lumens, using only the distance from the light point to the measuring device. Candela to lux -> (https://www.rapidtables.com/calc/light/candela-to-lux-calculator.html) If you do not have a device for measuring the luminous intensity you can try to obtain a value by calculating as from the power in watts (knowing the type of light). Watts to lumens -> (https://www.rapidtables.com/calc/light/watt-to-lumen-calculator.html)

The intensity of luminosity *

Set the intensity value in Lumens.

5000

Intensity at *

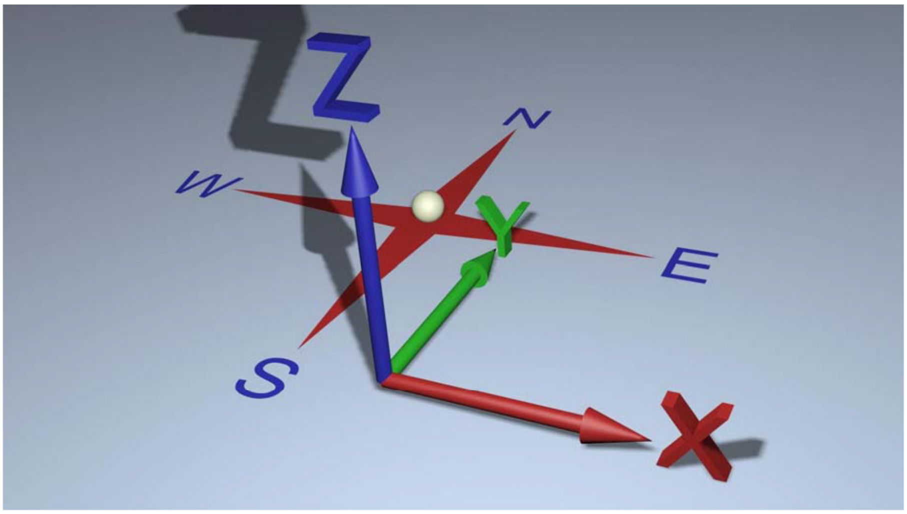
Set the distance at which the intensity is measured. Use the measurement in inches (39.3701 in - default).

40000

Shape / Area Shadows

Shape that the light is emitted. Corresponds to the shape of the light source. The light source has 6 possible types of shape already chosen previously (besides the option to be free or with a target). You now need informing of the values that will be used or not depending on the chosen format. Do not leave the fields blank even if the data is not used (enter any value to fields that will not be used). Point - does not use any of the shape data Linear - use only the length shape data Rectangle - use the length and width shape data Disc - use only the radius shape data Sphere - use only the radius shape data Cylinder - use the length and radius shape data The length is created in the Y-axis and the width is created in the X-axis.

The position of the three axes on the 3d software with the compass.



Light Length *

Set the length of the Area light where applicable. The length is created in the Y-axis and the width is created in the X-axis. Use the measurement in inches (122 in - default).

122

Light Width *

Set the width of the Area light where applicable. The length is created in the Y-axis and the width is created in the X-axis. Use the measurement in inches (61 in - default).

61

Light Radius *

Set the radius of the Area light where applicable. Use the measurement in inches (13 in - default).

13

Tip for the next step (the type of light distribution)

The Photometric Web File option allows you to later select a file with .ies or .cibse or .ltli extensions. Web distribution is based on a geometric mesh that models the intensity distribution pattern of a light source. In general, IES files result in more accurate lighting results in rendered images. For more information please visit the websites suggested below. (https://knowledge.autodesk.com/support/3ds-max/learn-explore/caas/CloudHelp/cloudhelp/2019/ENU/3DSMax-Lighting-Shading/files/GUID-8CF2ABB6-41F1-48B4-9BA3-C8E8C47941B6-htm.html) (https://knowledge.autodesk.com/support/revit-products/learn-explore/caas/CloudHelp/cloudhelp/2015/ENU/Revit-DocumentPresent/files/GUID-21089EF8-4DD4-4DCE-A7F7-C21F7B239E21-htm.html)

Type of Light Distribution *

Set the distribution type (Uniform Sphereical - default).

- (●) Uniform Sphereical
- ( ) Spotlight (not valid for Sphere and Cylinder types)
- ( ) Uniform Hemispherical (not valid for Sphere and Cylinder types)
- ( ) Photometric Web File (not valid for Sphere and Cylinder types)

Show Cone *

Turns display of the cone on or off. Set cone visible or not in viewport when unselected. Used only when the Distribution is set to Spotlight. Answer even if the data is not used (the selected distribution was not a Spotlight type) (off - default).

off

Hotspot / Beam *

The angle of a light's cone. The Hotspot value is measured in degrees. Used only when the Distribution is set to Spotlight. Answer even if the data is not used (the selected distribution was not a Spotlight type) (43 - default).

43

Falloff / Field *

The angle of a light's falloff. The Falloff value is measured in degrees. Used only when the Distribution is set to Spotlight. Answer even if the data is not used (the selected distribution was not a Spotlight type) (45 - default).

45

Cast Shadows *

When on, the light will cast shadows on objects (off - default).

off

Shadow Multiplier *

Controls the density of the shadow. Lower values make the shadow more transparent (1 - default).

1

Light Affects Shadow *

When on, blends the light's color with the shadow color (or shadow colors, if the shadow is mapped) (off - default).

off

Tip for the next step (color temperature of light in Kelvin)

If you do not have a color meter you can try to use a reference table to get an approximate color temperature value.

Kelvin Color Temperatures

Degrees Kelvin	Type of Light Source	Indoor (3200k) Color Balance	Outdoor (5500k) Color Balance
1700-1800K	Match Flame		
1850-1930K	Candle Flame		
2000-3000K	Sun: At Sunrise or Sunset		
2500-2900K	Household Tungsten Bulbs		
3000K	Tungsten lamp 500W-1k		
3200-3500K	Quartz Lights		
3200-7500K	Fluorescent Lights		
3275K	Tungsten Lamp 2k		
3380K	Tungsten Lamp 5k, 10k		
5000-5400K	Sun: Direct at Noon		
5500-6500K	Daylight (Sun + Sky)		
5500-6500K	Sun: through clouds/haze		
6000-7500K	Sky: Overcast		
6500K	RGB Monitor (White Pt.)		
7000-8000K	Outdoor Shade Areas		
8000-10000K	Sky: Partly Cloudy		

Based on information from the book [digital] Lighting & Rendering
Chart and colors (c)2003 Jeremy Birn for www.3dRender.com

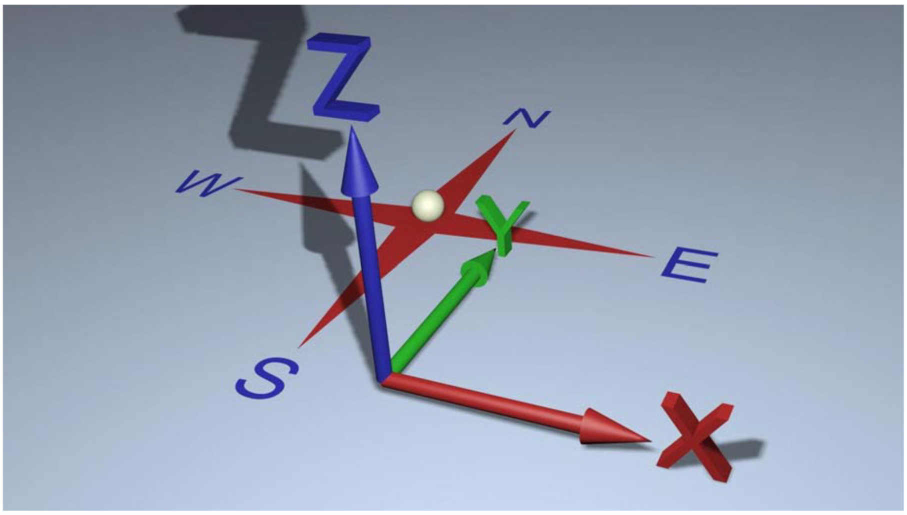
Color Temperature of Light in Kelvin *

Set the color temperature of light in Kelvin (3600 - default).

3600

Spatial Position of Light
Compulsory and indispensable data.

The position of the three axes on the 3d software with the compass.



Spatial Position of Light - X Axis *
Use the measurement in inches.

7

Spatial Position of Light - Y Axis *
Use the measurement in inches.

7

Spatial Position of Light - Z Axis *
Use the measurement in inches.

7

Spatial Position of the Target of Light
Compulsory and indispensable data only for the Target Lights. If you are not using one of it, enter any value in the fields, only so as not to leave them blank.

Spatial Position of the Target of Light - X Axis *

Use the measurement in inches.

80

Spatial Position of the Target of Light - Y Axis *

Use the measurement in inches.

80

Spatial Position of the Target of Light - Z Axis *

Use the measurement in inches.

80

End of data collection for photometric light 01

Add light photometric 02? *

You will not be able to add new photometric category lights later.

- ( ) Yes, collect data for a new photometric light.
- (•) No, there are no more lights in the scene, continue to collect data from other elements.

Reference Objects

In this section, it will be possible to collect data related to some types of reference objects. Moreover, it is possible to stay alert to use other reference objects in the moment of filming. The collection of data for reference objects follows the following order: - Reference Balls (Mirror and Gray); - Plans; - Reference Rod. Attention, data collection follows the order above. For example, it is not possible first to add reference rod and after add reference balls. You also will see reminders about other important types of reference instruments (and images/film to be produced for specific situations), such as: - ColorChecker; - Chroma-Key References for Camera Trackers; - Creation of photos or film in 360° for reflections. Alert: Do not forget that it is essential to use these reference objects at the time of filming. The data collected here is for the creation of virtual reference objects for later calibration of the 3D virtual universe in relation to the actual images shot.

Reference Balls and ColorChecker

Reference Objects *

They are useful for reference to the color of light, the angle of incidence of light, position, and intensity of the shadows, and the proportion of the virtual objects to be created.

- (●) Yes, I want to use them.
- ( ) No, I'm not interested, skip to next step.

Reference Balls

The purpose of those balls is to record the sources and distribution of lighting in the scene so that later on, the visual effects team can match the virtual lighting of the CGI elements that will be added to the shot.

Mirror and Grey Reference Balls

Virtual and real reference balls together.

Perform data collection for reference balls? *

- [x] Yes, I want to collect data for the creation of virtual reference balls.
- [ ] No, go to the next type of reference object.

Reference Balls Data Collection

Collect data for grey reference ball

Normally the gray color is 18% relative luminosity. On a sRGB ashes scale that can be seen on a common monitor, the relative luminosity 18% gray corresponds to the gray 50% positioned in the center of the scale sRGB. Tip: If you do not have a professional gray ball for reference, use a white styrofoam ball.

Name of reference grey ball *

The name is limited to 30 characters with spaces.

grey ball

Size of Grey Reference Ball *

For size should be informed the radius of the ball in inches.

20

Number of Segments of Grey Reference Ball *

The number of polygonal divisions for the sphere. The higher the number, the better the representation quality of the sphere (32 - default).

50

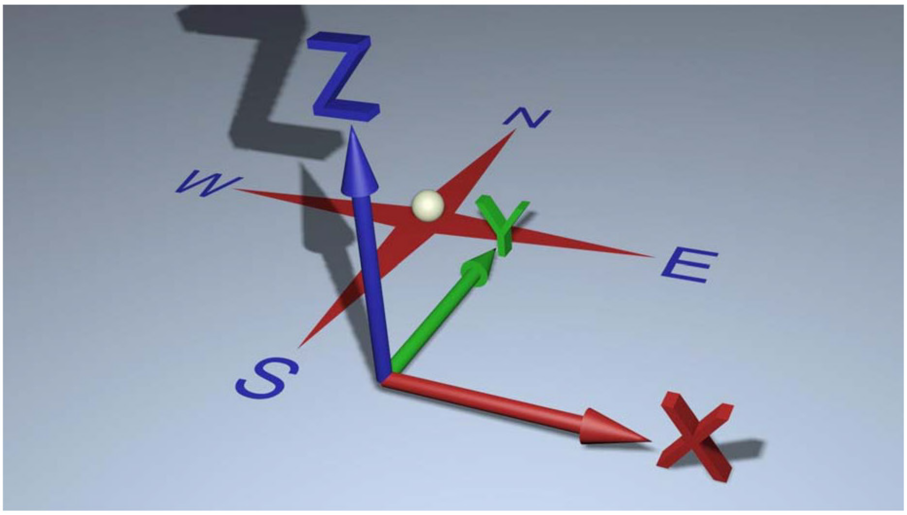
Ball Color (Grey or White) *

Grey color (18% relative luminosity)

Grey Ball Spatial Position

Use as a reference point for the position of the sphere their base (the point that touches the ground) and not their center.

The position of the three axes on the 3d software with the compass.



Spatial Position of the Grey Ball - X Axis *

Use the measurement in inches.

90

Spatial Position of the Grey Ball - Y Axis *

Use the measurement in inches.

90

Spatial Position of the Grey Ball - Z Axis *

Use as a reference point for the position of the sphere their base (the point that touches the ground) and not their center. Use the measurement in inches.

90

Collect data for mirrored reference ball

It is also used to record the sources and distribution of illumination in the scene, but it better shows the points of light and other elements of the scene that directly interfere with the illumination of the environment. It is possible to note for example whether the sky is overcast or not, or what color the floor or the surrounding environment. Tip: If you do not have a professional mirror ball for reference, use a mirrored Christmas ball.

Name of reference mirrored ball *

The name is limited to 30 characters with spaces.

bola espelhada

Size of Mirrored Reference Ball *

For size should be informed the radius of the ball in inches.

60

Number of Segments of Mirrored Reference Ball *

The number of polygonal divisions for the sphere. The higher the number, the better the representation quality of the sphere (32 - default).

60

Mirror Ball Spatial Position

Use as a reference point for the position of the sphere their base (the point that touches the ground) and not their center.

Spatial Position of the Mirror Ball - X Axis *

Use the measurement in inches.

33

Spatial Position of the Mirror Ball - Y Axis *

Use the measurement in inches.

33

Spatial Position of the Mirror Ball - Z Axis *

Use as a reference point for the position of the sphere their base (the point that touches the ground) and not their center. Use the measurement in inches.

33

End of data collection for reference balls

Data Collection for a Plan

In this step, it will be possible to collect data for one plan. This plan can be used for the construction of a floor or a table, for example. The tool will create via Script the plan where an object or virtual character will be acting. So, this plan can be created opaque, without transparency, or set for being "transparent" receiving and generating shadows (and reflections if existing) to be exported later with alpha channel.

A plane with matte/shadow material with alpha channel

Perform data collection for a reference plane? *

- (selected) Yes, I want to collect data for the creation of virtual reference plans.
- No, go to the next type of reference object.

Data Collection for a Reference Plane

Types of material for the plane

If the plan uses a standard it will be created in white color and will not have matte characteristics (transparency for compositions). On the other hand, if the "Matte / Shadow Material" is used, the plane will not be rendered, being transparent, but the shadows received in the plane will be rendered. However, if the selected material is "Matte / Shadow / Reflection" then in addition to rendering the shadows the material will also receive and render the reflections received by the plane. The materials created and used will be available in the library of materials and may later be used for the application in other three-dimensional elements that will need to be modeled to receive shadows (and reflexes).

Plane - material to be used *

Attention: If selected the "Matte / Shadow / Reflection Material" it will be changed automatically the renderer production and material editor in Assing Renderer to Mental Ray to support the reflection properties.

Matte / Shadow Material - (Default Scanline Renderer)

Name of plane *

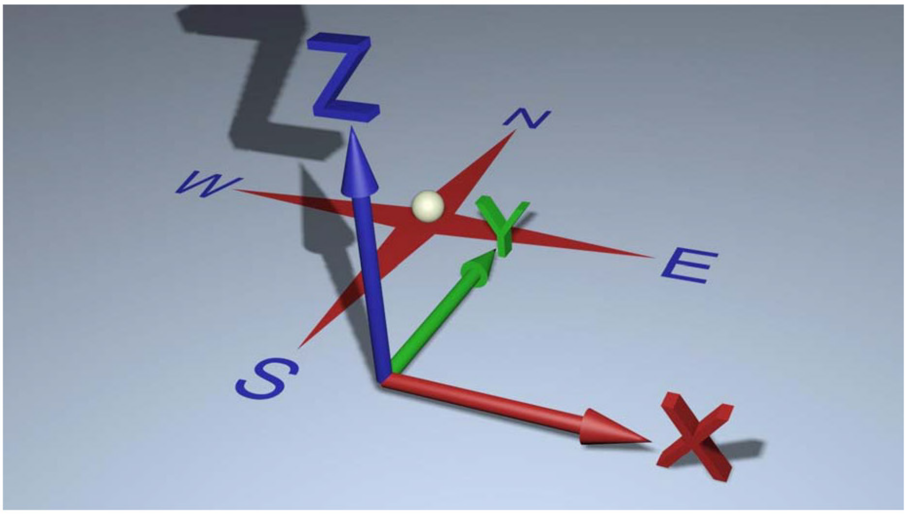
The name is limited to 30 characters with spaces.

chão

Length and Width of Plane

The length measurement occurs on the Y-axis and the width measurement occurs on the X-axis.

The position of the three axes on the 3d software with the compass.



Length of plane *

This measurement occurs on the Y-axis. Use the measurement in inches.

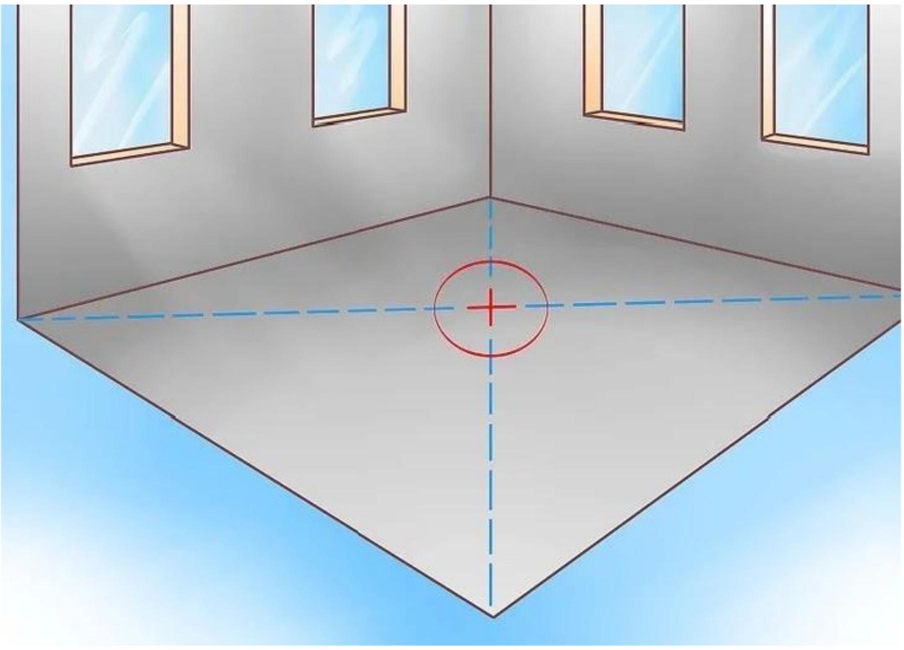
60

Width of plane *

This measurement occurs on the X-axis. Use the measurement in inches.

120

Center of a rectangle for taking it spatial position



Spatial Position of the Plane

The spatial position of the plane is taken from its center of symmetry, which is where its diagonals intersect.

Spatial Position of the Plane - X Axis *

Use the measurement in inches.

2

Spatial Position of the Plane - Y Axis *

Use the measurement in inches.

43

Spatial Position of the Plane - Z Axis *

Use the measurement in inches.

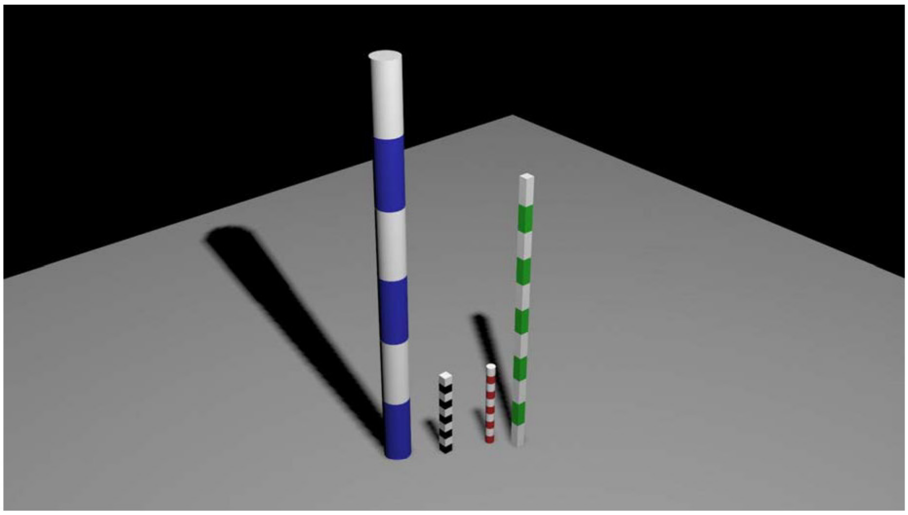
10

End of data collection for reference plane

Data Collection for Reference Rod

To use a reference rod it is interesting that it exists in the real world and be used at the time of shooting the scene too, but its possible create then only in the 3d virtual world. In the real world, it is useful for the actors to know better the proportion of virtual elements that can't see (sometimes it is used a chroma-key puppet or actor with chroma-key clothes). In the 3d virtual world, it is used as a reference rod to check if the position of the virtual elements was put correctly, check if the virtual object (or character) is on correct proportions and confirm the position and intensity of the shadows. To use in the moment of filming it is usually made using a wooden stick, PVC pipe, or other material (preferably lightweight, portable, mountable if required). The size of the rod will depend on the proportion of what you want to reference. If the intention is to reference something small, the stick and its references will be of lesser size and value, if large, the references and the stick itself will be majors. The shape of the stick is not important (if it is square or cylindrical), what matters is the colored subdivisions using the same known measure. For example, 5 inches intervals or 25 inches intervals (the same interval in all the rod). The script will create a reference rod made with cubes in a gradient color scale.

Reference rod examples with different section sizes



Perform data collection for reference rod? *

- (●) Yes, I want to collect data for the creation of virtual reference rod.
- ( ) No, go to the next step.

Reference Rod Data Collection

Name of reference rod *

The name is limited to 30 characters with spaces.

bastao de ref

Thickness for the reference rod *

The virtual bar will have a cubic and non-cylindrical shape. Use the measurement in inches.

5

Reference section size *

Which will be repeated in the bar in a gradient color range. Use the measurement in inches.

5

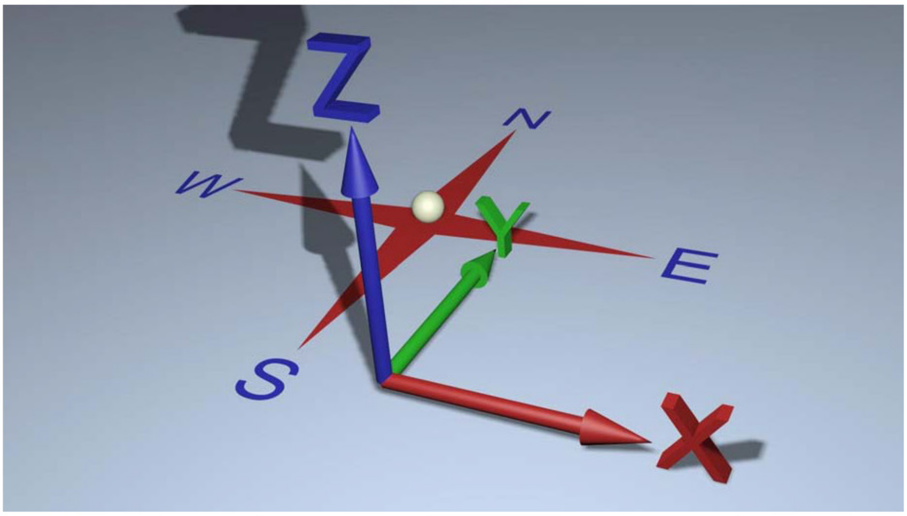
How many times that the section be repeated *

The size of the section with to the number of times it repeats will automatically indicate its height (this object is arranged vertically).

10

Spatial Position of the Reference Rod

The position of the three axes on the 3d software with the compass.



Spatial Position of the Reference Rod - X Axis *

Use the measurement in inches.

0

Spatial Position of the Reference Rod - Y Axis *

Use the measurement in inches.

0

Spatial Position of the Reference Rod - Z Axis *

Use the measurement in inches.

0

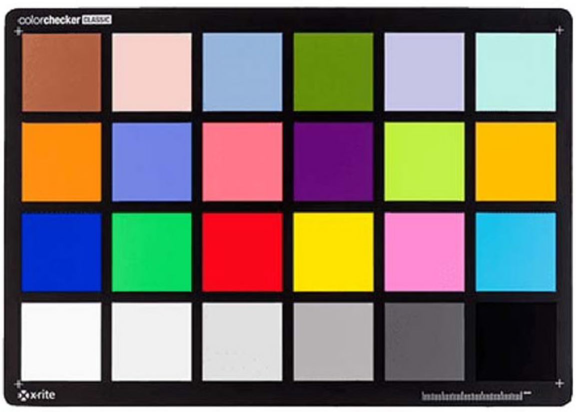
End of data collection for reference rod

Alert for other important references

Collect data for ColorCheck

The utilization of a "Macbeth ColorChecker" or other kinds as the "ColorChecker Video" or the "ColorChecker Passport Video" it is important because can be possible the best calibration of the cameras in the moment of filming and the future corrections in the post-production. There are a lot of kinds of color checkers, as Datacolor SpyderCheckr 24, DSC Labs ChromaDuMonde 24+4, DSC Labs SMPTE OneShot, and a lot of others from X-Rite company too.

ColorCheck Classic



ColorChecker Passport Video

Tip, don't forget!

Do not forget that besides the correct calibration of the cameras (white, black, color, ISO, aperture, shutter speed, and others) it is indispensable that the monitors of the digital post-production equipment (laptops or notebooks) are also calibrated to represent the images of the form as faithful as possible. There are several hardware and software solutions for monitor calibration, such as X-Rite "i1Display Pro" or SpectraCal "C6 HDR2000".

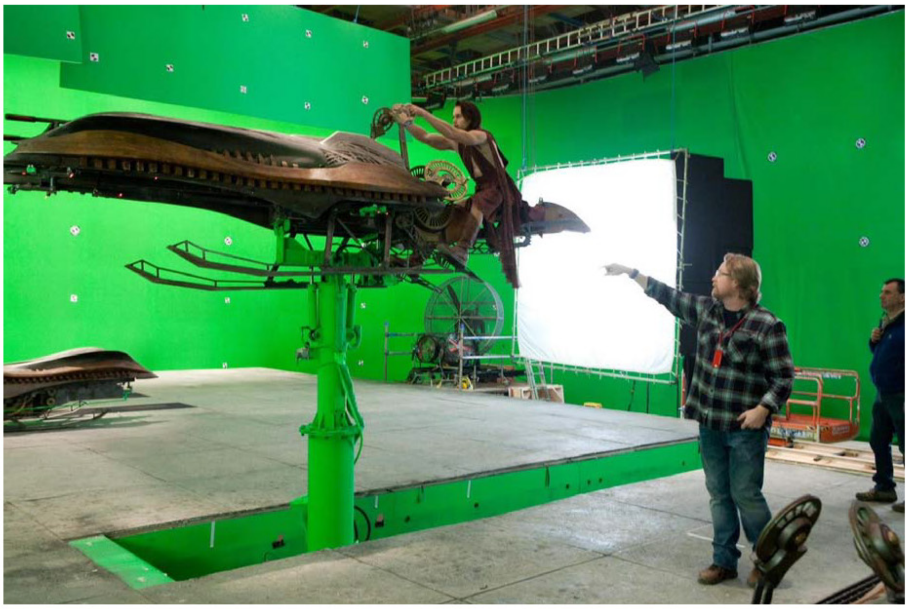
Chroma-Key References for Camera Trackers

If you are filming with a motion camera rather than with the stoped camera, you will probably use some camera tracking software after. This type of software can recreate the movement of the actual camera in a virtual camera so that the final composition is the most correct. If the scenario is real and only virtual objects or characters, these type of software will use the 2D image of the actual scene itself for tracking (the scenario cannot be very neutral, homogeneous and without spatial references to help the program). If the scenario is virtual (using chroma-key) then it is recommended to use visual reference for camera tracking (otherwise it may be impossible to track it). These references may be in a different color tone relative to the Chroma-Key itself, to facilitate its deletion later, or may have certain specific formats and colors, which need to be digitally removed afterward.

Referrals for camera tracking in another Chroma-Key tone

Other types of references for camera tracking.

Other types of references for camera tracking.

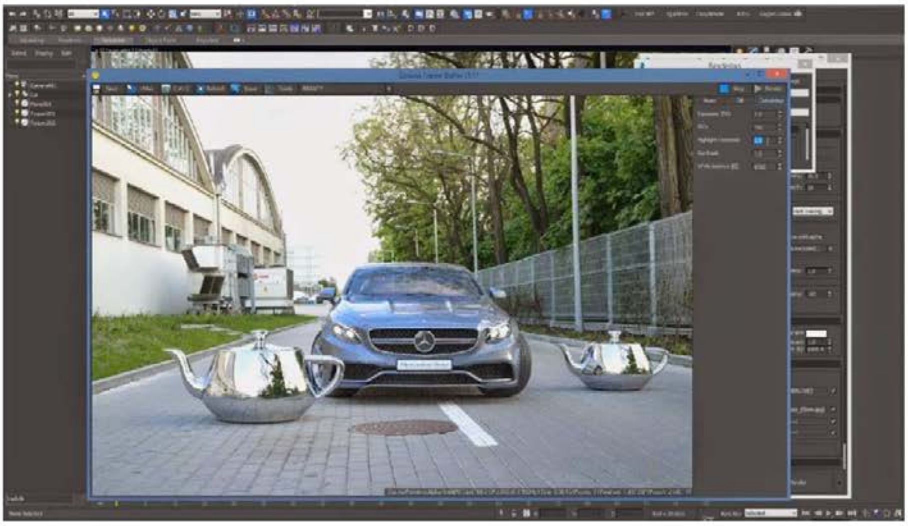


Creation of photos or film in 360º for reflections

If any virtual object or character, to be composed in a real scene, use some reflective material, it will be necessary to make the capture of the real environment for these reflections. To illustrate, the chrome wheel of a car, a glass object, polished metal, mirrored, all these elements will need an image of the environment in which they will be inserted to reflect later. The choice between a 360-degree static or moving image will depend on how much an with what detail these reflexes will be noticed and if will have importance in the narrative. To produce this type of images can be used specific cameras for filming or photo in 360 degrees or the use of adapter lenses for the same purpose.

360 degree photo

Car and teapots 3D reflecting the real ambient



End of alert for other important references

Data Collection for Render Setup

This information changes the appearance of the perspective viewport and rendering.

Width Output Size *

Use the measurement in pixels (the value 1920 for Full HD, or 720 for NTSC DV, for instance).

1920

Height Output Size *

Use the measurement in pixels (the value 1080 for Full HD, or 480 for NTSC DV, for instance).

1080

Pixel Aspect Ratio

Pixel aspect ratio (often abbreviated PAR) is a mathematical ratio that describes how the width of a pixel in a digital image compares to the height of that pixel. Most digital imaging systems display an image as a grid of tiny, square pixels. Pixel aspect ratio (PAR) is often confused with different types of image aspect ratios as display aspect ratio (abbreviated DAR, also known as image aspect ratio and picture aspect ratio) and storage aspect ratio (SAR).

Pixel Aspect Ratio *

Insert the pixel aspect. Square pixels is equal to 1,0 (the value 1 for Full HD, or 0,9 for NTSC DV, for instance).

1

End of data collection for render setup

Presets for 3ds Max File

Because one scene (and file) can contain multiple virtual cameras at the same time, the settings below will define the 3ds Max file characteristics.

Frame Rate *

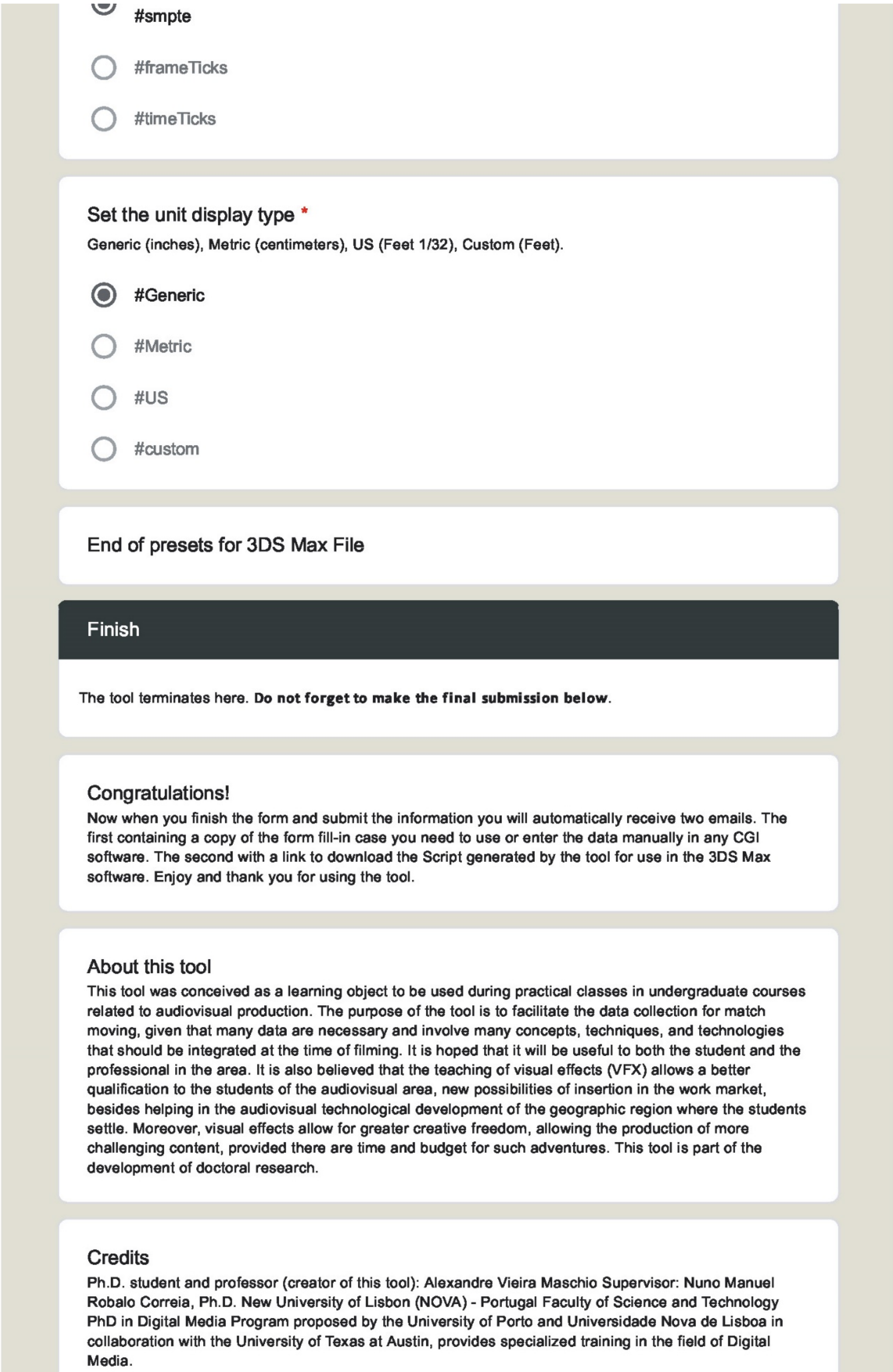
Some standards: 30 for NTSC, 25 for PAL, 24 for Film.

24

Time Display Mode *

There are always 4800 ticks per second, this means that ticksPerFrame is dependent on the frames per second rate.

- #frames



#smpte

#frameTicks

#timeTicks

Set the unit display type *

Generic (inches), Metric (centimeters), US (Feet 1/32), Custom (Feet).

#Generic

#Metric

#US

#custom

End of presets for 3DS Max File

Finish

The tool terminates here. **Do not forget to make the final submission below**.

Congratulations!

Now when you finish the form and submit the information you will automatically receive two emails. The first containing a copy of the form fill-in case you need to use or enter the data manually in any CGI software. The second with a link to download the Script generated by the tool for use in the 3DS Max software. Enjoy and thank you for using the tool.

About this tool

This tool was conceived as a learning object to be used during practical classes in undergraduate courses related to audiovisual production. The purpose of the tool is to facilitate the data collection for match moving, given that many data are necessary and involve many concepts, techniques, and technologies that should be integrated at the time of filming. It is hoped that it will be useful to both the student and the professional in the area. It is also believed that the teaching of visual effects (VFX) allows a better qualification to the students of the audiovisual area, new possibilities of insertion in the work market, besides helping in the audiovisual technological development of the geographic region where the students settle. Moreover, visual effects allow for greater creative freedom, allowing the production of more challenging content, provided there are time and budget for such adventures. This tool is part of the development of doctoral research.

Credits

Ph.D. student and professor (creator of this tool): Alexandre Vieira Maschio Supervisor: Nuno Manuel Robalo Correia, Ph.D. New University of Lisbon (NOVA) - Portugal Faculty of Science and Technology PhD in Digital Media Program proposed by the University of Porto and Universidade Nova de Lisboa in collaboration with the University of Texas at Austin, provides specialized training in the field of Digital Media.

IX. The full version of the three forms answered by the students participating in the research (concept, relevance, and adequacy)

The following are the three complete forms created for the research with the students participating in the research (concept, relevance, and adequacy).

Avaliação do conceito do produto

Grupo 01

*Obrigatório

1. Endereço de e-mail *

2. Avalie abaixo o quanto você considera **relevante** esta ferramenta para os alunos de cursos relacionados à produção audiovisual. *

Marcar apenas uma oval.

0	1	2	3	4	5	6	7	8	9	10

3. Avalie abaixo o quanto você acredita que esta ferramenta **se diferencia** das demais que você já conhece. *

Marcar apenas uma oval.

0	1	2	3	4	5	6	7	8	9	10

4. Avalie abaixo qual a sua percepção sobre a **credibilidade** transmitida pela ferramenta. *

Marcar apenas uma oval.

0	1	2	3	4	5	6	7	8	9	10

5. Indique abaixo como você avalia sua **intenção de utilizar** a ferramenta. *

Marcar apenas uma oval.

0	1	2	3	4	5	6	7	8	9	10

6. Avalie o quanto você concorda com a afirmação abaixo: "Aprender, ter competência e qualificação para produzir efeitos visuais mais elaborados (integração entre imagens reais e virtuais em audiovisual) **poderá melhorar minhas possibilidades de inserção no mercado de trabalho**." *

Marcar apenas uma oval.

	0	1	2	3	4	5	6	7	8	9	10	
discordo totalmente	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	concordo totalmente

7. Avalie o quanto você concorda com a afirmação abaixo: "Aprender, ter competência e qualificação para produzir efeitos visuais mais elaborados (integração entre imagens reais e virtuais em audiovisual) **me permite ter maior liberdade criativa em meus projetos de audiovisual**." *

Marcar apenas uma oval.

	0	1	2	3	4	5	6	7	8	9	10	
discordo totalmente	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	concordo totalmente

8. Avalie, **o quanto você indicaria** a ferramenta (objeto de aprendizagem digital) a um colega, parente ou amigo? *

Marcar apenas uma oval.

	0	1	2	3	4	5	6	7	8	9	10	
não recomendaria com certeza	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	◯	recomendaria com certeza

9. Tendo em conta o que viu deste conceito e considerando o que existe atualmente no mercado para estes objetivos (apoio pedagógico para o ensino de efeitos visuais), você entenderia que **este produto seria**: *

Marcar apenas uma oval.

- ◯ 5 - muito melhor do que o que já existe atualmente
- ◯ 4 - melhor do que o que já existe atualmente
- ◯ 3 - nem pior nem melhor do que o que já existe atualmente
- ◯ 2 - pior do que o que já existe atualmente
- ◯ 1 - muito pior do que o que já existe atualmente

Avaliação das características do produto

Grupo 01 - RELEVÂNCIA / IMPORTÂNCIA
*Obrigatório

1. Endereço de e-mail *

Iniciar a pesquisa

Atenção: as questões a seguir são compostas por um grupo de quatro características cada, você deverá assinalar em cada coluna **UMA** característica como menos importante e **UMA** característica como mais importante. Contudo **não se deve assinalar uma mesma característica como menos e mais importante ao mesmo tempo**. Além disso, por favor, **não deixe nenhuma coluna em branco** (sem resposta). Obrigado.

Página 01 de 08

2. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Nível mediano de exigência – das demandas necessárias para que o estudante possa acessar, interpretar e processar as instruções da ferramenta e fazer uso dela.	☐	☐
Coerência – lógica, sentido entre: os conteúdos, os objetivos, as atividades desenvolvidas, a avaliação e o perfil do aluno.	☐	☐
Qualidade dos conteúdos – conceitos, informações, referências, imagens etc., utilizados na ferramenta (reforçam pontos chave e ideias significativas).	☐	☐
Conforto – percepção de sensação confortável durante a utilização da ferramenta.	☐	☐

3. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

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Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Estética – disposição e escolha dos elementos como textos, links, imagens, vídeos. Considerando as limitações em formulários.	☐	☐
Interatividade – permite ao indivíduo interagir ao possibilitar a escolha de quais dados e informações o usuário que coletar ou ter acesso.	☐	☐
Autonomia – permite que os alunos realizem as atividades sem intervenção do professor, encorajando a exploração e o envolvimento.	☐	☐
Eficiência – percepção de ser competente, produtiva, de conseguir o melhor rendimento com o mínimo de erros e/ou dispêndios.	☐	☐

4. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Conteúdos – abordados de maneira clara e precisa, com adequação e coerência ao público alvo. Também não apresentam omissões ou preconceito.	☐	☐
Ludicidade – percepção de que o uso da ferramenta é prazeroso, divertido.	☐	☐
Aprendizagem colaborativa – possibilita a parceria entre os alunos/usuários para melhor desempenho das atividades.	☐	☐
Facilidade de uso – percepção de facilidade de uso da ferramenta.	☐	☐

5. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Acessibilidade – dependência de internet; acessível por qualquer navegador e sistema operacional.	☐	☐
Satisfação – contentamento, prazer advindo da realização do que se espera, do que se deseja no uso da ferramenta.	☐	☐
Pertinência pedagógica – apropriada e relevante no contexto educacional em que está inserida.	☐	☐
Reutilização – passível de ser reutilizada em diferentes contextos de ensino e produção audiovisual, como servir de referência para outros professores.	☐	☐

Atenção:
Por favor, revise se não ficou nenhuma coluna sem resposta antes de prosseguir para a próxima página. Obrigado.

Página 02 de 08

6. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Auxílio no aprendizado – proporcionado pela ferramenta enquanto recurso educacional (objeto de aprendizagem).	☐	☐
Autoexplicativa – percepção de capacidade autoexplicativa durante seu uso.	☐	☐
Objetivos pedagógicos – identificáveis e adequados ao público alvo. Auxílio nas atividades práticas de produção audiovisual com interação real x virtual.	☐	☐
Conveniência – percepção de que pode ser utilizada para descomplicar uma rotina; que pode trazer vantagens para a pessoa que a utiliza.	☐	☐

7. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Valor econômico (custo) – gratuita.	☐	☐
Texto multimodal – ao integrar nos momentos necessários texto e imagem ou texto e vídeo para um melhor entendimento do conceito ao utilizador.	☐	☐
Metadados – presentes no website da ferramenta em conformidade com as padronizações dos repositórios de Objetos de Aprendizagem.	☐	☐
Motivação – conjunto de processos que dão ao comportamento uma intensidade, uma direção determinada durante a utilização da ferramenta.	☐	☐

8. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Funcionalidade técnica – se ela cumpre seus propósitos: auxílio na coleta de dados e automatização na transferência destes para software de computação gráfica 3D.	☐	☐
Linguagem – favorece o entendimento e a aprendizagem.	☐	☐
Organização – percepção de organização (forma de navegação e subdivisão em etapas).	☐	☐
Idioma – idioma inglês, uso internacional, majoritário em softwares da área.	☐	☐

9. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Adaptabilidade – opções de navegação para se adaptar às necessidades do aluno, tornando-se intuitiva.	☐	☐
Mensagens de erro – quando ocorrem identificam claramente o erro que está ocorrendo e apresenta solução para ele.	☐	☐
Aprendizagem ativa – tira o aluno do papel passivo de ouvinte para um aluno ativo que constrói o seu conhecimento (aprender a aprender).	☐	☐
Utilidade – percepção de que a utilização da ferramenta é válida.	☐	☐

Atenção:

Por favor, revise se não ficou nenhuma coluna sem resposta antes de prosseguir para a próxima página. Obrigado.

Página 03 de 08

10. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Quantidade de informação – suficiente e não excessiva.	☐	☐
Estrutura instrucional de orientação ao professor – qualidade e suficiência dos conteúdos instrucionais no website da ferramenta.	☐	☐
Desafiante – faz surgir, desperta, instiga, suscita o enfrentamento, o se pôr à prova.	☐	☐
Adequação pedagógica – apresenta conformidade ao contexto educacional em que está inserida.	☐	☐

11. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Ludicidade – percepção de que o uso da ferramenta é prazeroso, divertido.	☐	☐
Nível mediano de exigência – das demandas necessárias para que o estudante possa acessar, interpretar e processar as instruções da ferramenta e fazer uso dela.	☐	☐
Eficiência – percepção de ser competente, produtiva, de conseguir o melhor rendimento com o mínimo de erros e/ou dispêndios.	☐	☐
Aprendizagem ativa – tira o aluno do papel passivo de ouvinte para um aluno ativo que constrói o seu conhecimento (aprender a aprender).	☐	☐

12. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Qualidade dos conteúdos – conceitos, informações, referências, imagens etc., utilizados na ferramenta (reforçam pontos chave e ideias significativas).	☐	☐
Reutilização – passível de ser reutilizada em diferentes contextos de ensino e produção audiovisual, como servir de referência para outros professores.	☐	☐
Auxílio no aprendizado – proporcionado pela ferramenta enquanto recurso educacional (objeto de aprendizagem).	☐	☐
Pertinência pedagógica – apropriada e relevante no contexto educacional em que está inserida.	☐	☐

13. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Facilidade de uso – percepção de facilidade de uso da ferramenta.	☐	☐
Estética – disposição e escolha dos elementos como textos, links, imagens, vídeos. Considerando as limitações em formulários.	☐	☐
Estrutura instrucional de orientação ao aluno – qualidade e suficiência dos conteúdos instrucionais no website da ferramenta.	☐	☐
Adaptabilidade – opções de navegação para se adaptar às necessidades do aluno, tornando-se intuitiva.	☐	☐

Atenção:

Por favor, revise se não ficou nenhuma coluna sem resposta antes de prosseguir para a próxima página. Obrigado.

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14. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Utilidade – percepção de que a utilização da ferramenta é válida.	☐	☐
Autonomia – permite que os alunos realizem as atividades sem intervenção do professor, encorajando a exploração e o envolvimento.	☐	☐
Satisfação – contentamento, prazer advindo da realização do que se espera, do que se deseja no uso da ferramenta.	☐	☐
Texto multimodal – ao integrar nos momentos necessários texto e imagem ou texto e vídeo para um melhor entendimento do conceito ao utilizador.	☐	☐

15. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Adequação pedagógica – apresenta conformidade ao contexto educacional em que está inserida.	☐	☐
Idioma – idioma inglês, uso internacional, majoritário em softwares da área.	☐	☐
Autoexplicativa – percepção de capacidade autoexplicativa durante seu uso.	☐	☐
Valor econômico (custo) – gratuita.	☐	☐

16. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Conforto – percepção de sensação confortável durante a utilização da ferramenta.	☐	☐
Quantidade de informação – suficiente e não excessiva.	☐	☐
Funcionalidade técnica – se ela cumpre seus propósitos: auxílio na coleta de dados e automatização na transferência destes para software de computação gráfica 3D.	☐	☐
Metadados – presentes no website da ferramenta em conformidade com as padronizações dos repositórios de Objetos de Aprendizagem.	☐	☐

17. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Interatividade – permite ao indivíduo interagir ao possibilitar a escolha de quais dados e informações o usuário que coletar ou ter acesso.	☐	☐
Documentação de apoio – informações a respeito da ferramenta. Contidas nela mesma e no site referente à pesquisa de doutoramento e a ferramenta.	☐	☐
Coerência – lógica, sentido entre: os conteúdos, os objetivos, as atividades desenvolvidas, a avaliação e o perfil do aluno.	☐	☐
Organização – percepção de organização (forma de navegação e subdivisão em etapas).	☐	☐

Atenção:

Por favor, revise se não ficou nenhuma coluna sem resposta antes de prosseguir para a próxima página. Obrigado.

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18. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Estrutura instrucional de orientação ao professor – qualidade e suficiência dos conteúdos instrucionais no website da ferramenta.	☐	☐
Objetivos pedagógicos – identificáveis e adequados ao público alvo. Auxílio nas atividades práticas de produção audiovisual com interação real x virtual.	☐	☐
Mensagens de erro – quando ocorrem identificam claramente o erro que está ocorrendo e apresenta solução para ele.	☐	☐
Feedback – recebido pelo professor durante a execução das atividades foi importante para a utilização da ferramenta e compreensão do conteúdo relacionado.	☐	☐

19. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Aprendizagem colaborativa – possibilita a parceria entre os alunos/usuários para melhor desempenho das atividades.	☐	☐
Motivação – conjunto de processos que dão ao comportamento uma intensidade, uma direção determinada durante a utilização da ferramenta.	☐	☐
Conveniência – percepção de que pode ser utilizada para descomplicar uma rotina; que pode trazer vantagens para a pessoa que a utiliza.	☐	☐
Linguagem – favorece o entendimento e a aprendizagem.	☐	☐

20. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Motivação – conjunto de processos que dão ao comportamento uma intensidade, uma direção determinada durante a utilização da ferramenta.	☐	☐
Aprendizagem ativa – tira o aluno do papel passivo de ouvinte para um aluno ativo que constrói o seu conhecimento (aprender a aprender).	☐	☐
Adequação pedagógica – apresenta conformidade ao contexto educacional em que está inserida.	☐	☐
Conteúdos – abordados de maneira clara e precisa, com adequação e coerência ao público alvo. Também não apresentam omissões ou preconceito.	☐	☐

21. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Texto multimodal – ao integrar nos momentos necessários texto e imagem ou texto e vídeo para um melhor entendimento do conceito ao utilizador.	☐	☐
Acessibilidade – dependência de internet; acessível por qualquer navegador e sistema operacional.	☐	☐
Idioma – idioma inglês, uso internacional, majoritário em softwares da área.	☐	☐
Qualidade dos conteúdos – conceitos, informações, referências, imagens etc., utilizados na ferramenta (reforçam pontos chave e ideias significativas).	☐	☐

Atenção:

Por favor, revise se não ficou nenhuma coluna sem resposta antes de prosseguir para a próxima página. Obrigado.

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22. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Organização – percepção de organização (forma de navegação e subdivisão em etapas).	☐	☐
Conforto – percepção de sensação confortável durante a utilização da ferramenta.	☐	☐
Utilidade – percepção de que a utilização da ferramenta é válida.	☐	☐
Estética – disposição e escolha dos elementos como textos, links, imagens, vídeos. Considerando as limitações em formulários.	☐	☐

23. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Coerência – lógica, sentido entre: os conteúdos, os objetivos, as atividades desenvolvidas, a avaliação e o perfil do aluno.	☐	☐
Estrutura instrucional de orientação ao aluno – qualidade e suficiência dos conteúdos instrucionais no website da ferramenta.	☐	☐
Quantidade de informação – suficiente e não excessiva.	☐	☐
Ludicidade – percepção de que o uso da ferramenta é prazeroso, divertido.	☐	☐

24. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Documentação de apoio – informações a respeito da ferramenta. Contidas nela mesma e no site referente à pesquisa de doutoramento e a ferramenta.	☐	☐
Funcionalidade técnica – se ela cumpre seus propósitos: auxílio na coleta de dados e automatização na transferência destes para software de computação gráfica 3D.	☐	☐
Facilidade de uso – percepção de facilidade de uso da ferramenta.	☐	☐
Autoexplicativa – percepção de capacidade autoexplicativa durante seu uso.	☐	☐

25. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Feedback – recebido pelo professor durante a execução das atividades foi importante para a utilização da ferramenta e compreensão do conteúdo relacionado.	☐	☐
Desafiante – faz surgir, desperta, instiga, suscita o enfrentamento, o se pôr à prova.	☐	☐
Linguagem – favorece o entendimento e a aprendizagem.	☐	☐
Autonomia – permite que os alunos realizem as atividades sem intervenção do professor, encorajando a exploração e o envolvimento.	☐	☐

Atenção:

Por favor, revise se não ficou nenhuma coluna sem resposta antes de prosseguir para a próxima página. Obrigado.

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26. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Objetivos pedagógicos – identificáveis e adequados ao público alvo. Auxílio nas atividades práticas de produção audiovisual com interação real x virtual.	☐	☐
Aprendizagem colaborativa – possibilita a parceria entre os alunos/usuários para melhor desempenho das atividades.	☐	☐
Interatividade – permite ao indivíduo interagir ao possibilitar a escolha de quais dados e informações o usuário que coletar ou ter acesso.	☐	☐
Satisfação – contentamento, prazer advindo da realização do que se espera, do que se deseja no uso da ferramenta.	☐	☐

27. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Metadados – presentes no website da ferramenta em conformidade com as padronizações dos repositórios de Objetos de Aprendizagem.	☐	☐
Auxílio no aprendizado – proporcionado pela ferramenta enquanto recurso educacional (objeto de aprendizagem).	☐	☐
Nível mediano de exigência – das demandas necessárias para que o estudante possa acessar, interpretar e processar as instruções da ferramenta e fazer uso dela.	☐	☐
Estrutura instrucional de orientação ao professor – qualidade e suficiência dos conteúdos instrucionais no website da ferramenta.	☐	☐

28. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Eficiência – percepção de ser competente, produtiva, de conseguir o melhor rendimento com o mínimo de erros e/ou dispêndios.	☐	☐
Conveniência – percepção de que pode ser utilizada para descomplicar uma rotina; que pode trazer vantagens para a pessoa que a utiliza.	☐	☐
Valor econômico (custo) – gratuita.	☐	☐
Mensagens de erro – quando ocorrem identificam claramente o erro que está ocorrendo e apresenta solução para ele.	☐	☐

29. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Estrutura instrucional de orientação ao aluno – qualidade e suficiência dos conteúdos instrucionais no website da ferramenta.	☐	☐
Feedback – recebido pelo professor durante a execução das atividades foi importante para a utilização da ferramenta e compreensão do conteúdo relacionado.	☐	☐
Acessibilidade – dependência de internet; acessível por qualquer navegador e sistema operacional.	☐	☐
Documentação de apoio – informações a respeito da ferramenta. Contidas nela mesma e no site referente à pesquisa de doutoramento e a ferramenta.	☐	☐

Atenção:

Por favor, revise se não ficou nenhuma coluna sem resposta antes de prosseguir para a próxima página. Obrigado.

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30. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Reutilização – passível de ser reutilizada em diferentes contextos de ensino e produção audiovisual, como servir de referência para outros professores.	☐	☐
Pertinência pedagógica – apropriada e relevante no contexto educacional em que está inserida.	☐	☐
Adaptabilidade – opções de navegação para se adaptar às necessidades do aluno, tornando-se intuitiva.	☐	☐
Acessibilidade – dependência de internet; acessível por qualquer navegador e sistema operacional.	☐	☐

31. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** importante/relevante para o produto.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Importante	MAIS Importante
Pertinência pedagógica – apropriada e relevante no contexto educacional em que está inserida.	☐	☐
Conteúdos – abordados de maneira clara e precisa, com adequação e coerência ao público alvo. Também não apresentam omissões ou preconceito.	☐	☐
Reutilização – passível de ser reutilizada em diferentes contextos de ensino e produção audiovisual, como servir de referência para outros professores.	☐	☐
Desafiante – faz surgir, desperta, instiga, suscita o enfrentamento, o se pôr à prova.	☐	☐

Atenção:

Por favor, revise se não ficou nenhuma coluna sem resposta antes de prosseguir. Obrigado.

Após o envio não será possível alterar as características que assinalou, nem deverá responder novamente o formulário. Portanto, este é o momento de revisar ou fazer qualquer alteração que julgar necessária, antes de clicar no botão ENVIAR.

Avaliação das características do produto

Grupo 01 - ADEQUAÇÃO

*Obrigatório

1. Endereço de e-mail *

Iniciar a pesquisa

Atenção: as questões a seguir são compostas por um grupo de quatro características cada, você deverá assinalar em cada coluna **UMA** característica como menos adequada e **UMA** característica como mais adequada. Contudo **não se deve assinalar uma mesma característica como menos e mais adequada ao mesmo tempo**. Além disso, por favor, **não deixe nenhuma coluna em branco** (sem resposta). Obrigado.

Página 01 de 03

2. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** adequada no produto que utilizou.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Adequada	MAIS Adequada
Estética – disposição e escolha dos elementos como textos, links, imagens, vídeos. Considerando as limitações em formulários.	☐	☐
Acessibilidade – dependência de internet; acessível por qualquer navegador e sistema operacional.	☐	☐
Facilidade de uso – percepção de facilidade de uso da ferramenta.	☐	☐
Funcionalidade técnica – se ela cumpre seus propósitos: auxílio na coleta de dados e automatização na transferência destes para software de computação gráfica 3D.	☐	☐

3. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** adequada no produto que utilizou.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Adequada	MAIS Adequada
Utilidade – percepção de que a utilização da ferramenta é válida.	☐	☐
Conforto – percepção de sensação confortável durante a utilização da ferramenta.	☐	☐
Organização – percepção de organização (forma de navegação e subdivisão em etapas).	☐	☐
Documentação de apoio – informações a respeito da ferramenta. Contidas nela mesma e no site referente à pesquisa de doutoramento e a ferramenta.	☐	☐

4. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** adequada no produto que utilizou.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Adequada	MAIS Adequada
Motivação – conjunto de processos que dão ao comportamento uma intensidade, uma direção determinada durante a utilização da ferramenta.	☐	☐
Qualidade dos conteúdos – conceitos, informações, referências, imagens etc., utilizados na ferramenta (reforçam pontos chave e ideias significativas).	☐	☐
Metadados – presentes no website da ferramenta em conformidade com as padronizações dos repositórios de Objetos de Aprendizagem.	☐	☐
Adequação pedagógica – apresenta conformidade ao contexto educacional em que está inserida.	☐	☐

5. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** adequada no produto que utilizou.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Adequada	MAIS Adequada
Autonomia – aprendizagem ativa, colaborativa, independência do aluno.	☐	☐
Auxílio no aprendizado – proporcionado pela ferramenta enquanto recurso educacional (objeto de aprendizagem).	☐	☐
Objetivos pedagógicos – identificáveis e adequados ao público alvo. Auxílio nas atividades práticas de produção audiovisual com interação real x virtual.	☐	☐
Idioma – idioma inglês, uso internacional, majoritário em softwares da área.	☐	☐

Atenção:

Por favor, revise se não ficou nenhuma coluna sem resposta antes de prosseguir para a próxima página. Obrigado.

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6. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** adequada no produto que utilizou.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Adequada	MAIS Adequada
Documentação de apoio – informações a respeito da ferramenta. Contidas nela mesma e no site referente à pesquisa de doutoramento e a ferramenta.	☐	☐
Idioma – idioma inglês, uso internacional, majoritário em softwares da área.	☐	☐
Motivação – conjunto de processos que dão ao comportamento uma intensidade, uma direção determinada durante a utilização da ferramenta.	☐	☐
Acessibilidade – dependência de internet; acessível por qualquer navegador e sistema operacional.	☐	☐

7. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** adequada no produto que utilizou.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Adequada	MAIS Adequada
Funcionalidade técnica – se ela cumpre seus propósitos: auxílio na coleta de dados e automatização na transferência destes para software de computação gráfica 3D.	☐	☐
Organização – percepção de organização (forma de navegação e subdivisão em etapas).	☐	☐
Autonomia – aprendizagem ativa, colaborativa, independência do aluno.	☐	☐
Metadados – presentes no website da ferramenta em conformidade com as padronizações dos repositórios de Objetos de Aprendizagem.	☐	☐

8. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** adequada no produto que utilizou.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Adequada	MAIS Adequada
Auxílio no aprendizado – proporcionado pela ferramenta enquanto recurso educacional (objeto de aprendizagem).	☐	☐
Estética – disposição e escolha dos elementos como textos, links, imagens, vídeos. Considerando as limitações em formulários.	☐	☐
Utilidade – percepção de que a utilização da ferramenta é válida.	☐	☐
Qualidade dos conteúdos – conceitos, informações, referências, imagens etc., utilizados na ferramenta (reforçam pontos chave e ideias significativas).	☐	☐

9. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** adequada no produto que utilizou.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Adequada	MAIS Adequada
Adequação pedagógica – apresenta conformidade ao contexto educacional em que está inserida.	☐	☐
Facilidade de uso – percepção de facilidade de uso da ferramenta.	☐	☐
Conforto – percepção de sensação confortável durante a utilização da ferramenta.	☐	☐
Objetivos pedagógicos – identificáveis e adequados ao público alvo. Auxílio nas atividades práticas de produção audiovisual com interação real x virtual.	☐	☐

Atenção:
Por favor, revise se não ficou nenhuma coluna sem resposta antes de prosseguir para a próxima página. Obrigado.

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10. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** adequada no produto que utilizou.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Adequada	MAIS Adequada
Conforto – percepção de sensação confortável durante a utilização da ferramenta.	☐	☐
Metadados – presentes no website da ferramenta em conformidade com as padronizações dos repositórios de Objetos de Aprendizagem.	☐	☐
Acessibilidade – dependência de internet; acessível por qualquer navegador e sistema operacional	☐	☐
Auxílio no aprendizado – proporcionado pela ferramenta enquanto recurso educacional (objeto de aprendizagem).	☐	☐

11. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** adequada no produto que utilizou.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Adequada	MAIS Adequada
Objetivos pedagógicos – identificáveis e adequados ao público alvo. Auxílio nas atividades práticas de produção audiovisual com interação real x virtual.	☐	☐
Motivação – conjunto de processos que dão ao comportamento uma intensidade, uma direção determinada durante a utilização da ferramenta.	☐	☐
Estética– disposição e escolha dos elementos como textos, links, imagens, vídeos. Considerando as limitações em formulários.	☐	☐
Organização – percepção de organização (forma de navegação e subdivisão em etapas).	☐	☐

12. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** adequada no produto que utilizou.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Adequada	MAIS Adequada
Idioma – idioma inglês, uso internacional, majoritário em softwares da área.	☐	☐
Funcionalidade técnica– se ela cumpre seus propósitos: auxílio na coleta de dados e automatização na transferência destes para software de computação gráfica 3D.	☐	☐
Adequação pedagógica – apresenta conformidade ao contexto educacional em que está inserida.	☐	☐
Utilidade – percepção de que a utilização da ferramenta é válida.	☐	☐

13. Com base na experiência que teve com a ferramenta, entre as opções abaixo, escolha quais características você considera a **MENOS** e a **MAIS** adequada no produto que utilizou.

Atenção: uma característica não deve ser assinalada como MAIS e MENOS adequada ao mesmo tempo. Além disso é necessário que seja assinalada **uma característica em cada coluna**, não deixe nenhuma das colunas em branco.

Marque todas que se aplicam.

	MENOS Adequada	MAIS Adequada
Facilidade de uso – percepção de facilidade de uso da ferramenta.	☐	☐
Documentação de apoio – informações a respeito da ferramenta. Contidas nela mesma e no site referente à pesquisa de doutoramento e a ferramenta.	☐	☐
Qualidade dos conteúdos – conceitos, informações, referências, imagens etc., utilizados na ferramenta (reforçam pontos chave e ideias significativas).	☐	☐
Autonomia – aprendizagem ativa, colaborativa, independência do aluno.	☐	☐

Atenção:

Por favor, revise se não ficou nenhuma coluna sem resposta antes de prosseguir. Obrigado.

Após o envio não será possível alterar as características que assinalou, nem deverá responder novamente o formulário. Portanto, este é o momento de revisar ou fazer qualquer alteração que julgar necessária, antes de clicar no botão ENVIAR.

X. Instructions to evaluators on how to proceed with the blind evaluation

Instructions to evaluators on how to proceed to perform the blind evaluation

Dear evaluators Jorge, Dorneles, and Marcelo, are receiving along with these instructions the link to download and access 14 videos.

A - Each video must contain two compositions (real vs. virtual):
1st composition -> 3d character dancing
2nd composition -> PC cabinet falling

B - Provide a final grade for each of the compositions present in each of the videos to be evaluated.

To evaluate:

- Assess the likelihood of interaction in general. See elements such as shadows, lighting (color temperature, type of light, luminous power), as well as positioning, animation, movements, masks used for clipping, chroma-key, etc.
- Even its most abstract and subjective perception when enjoying the video (because the soundtrack itself, sound effects, the way it was set up {editing} also influences our perception). The video itself as a whole (context).
- Assess the correspondence of how the images in computer graphics (character and 3D object) integrate with the real images, what is the level of quality of this integration.

Registering your evaluation:

You can use the Excel Spreadsheet that is together to the files, as it will be able to evaluate each of the works and if you want to revise any notes during the evaluation of the other works, you will have greater freedom. Spreadsheet name -> "Record of Video Ratings"
Or,
You can use the Google Form I made to proceed with the Video Rating. Using the form, you will not be able to enter and change notes of videos that have already been evaluated. You can find it at the address below.
https://forms.gle/sg1mFv69tg6f1hzV7

Google is more structured and practical, the Excel spreadsheet allows more freedom.

Thank you,

Alexandre V. Maschio

XI. The form made available to the evaluators for the blind evaluation

Análise Cega (avaliador)

Formulário para análise cega a ser utilizado pelo avaliador para valoração dos audiovisuais produzidos durante minicurso.

*Obrigatório

1. Identificação do avaliador: *

   Marcar apenas uma oval.

   - Avaliador 01 (Jorge)
   - Avaliador 02 (Dorneles)
   - Avaliador 03 (Marcelo)

2. Trabalho a ser avaliado: *

   Marcar apenas uma oval.

   - Nº 01
   - Nº 03
   - Nº 06
   - Nº 07
   - Nº 08
   - Nº 09
   - Nº 10
   - Nº 13
   - Nº 14
   - Nº 15
   - Nº 16
   - Nº 17
   - Nº 18
   - Nº 19

3. Nota final sobre a PRIMEIRA composição (personagem 3D dançando). *

Marcar apenas uma oval.

0	1	2	3	4	5	6	7	8	9	10

4. Nota final sobre a SEGUNDA composição (queda do gabinete). *

Marcar apenas uma oval.

0	1	2	3	4	5	6	7	8	9	10

XII. Table with a list of course coordinators, institutions, courses, and contacts for research with professors

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Legenda das cores	
Tipo de curso	**Número encontrado**
Cursos de Nível Superior (Graduação) - Brasil	159
Cursos de Nível Tecnológo - Brasil	7
Cursos Livres - Brasil	14
Cursos de Nível Superior (Graduação) - Portugal	19
Cursos de Nível Tecnológo - Portugal	1
Total	200

XIII. Template used for direct mail contact with courses coordinators and teachers

Convite para participação em Pesquisa de Doutoramento

V.S.ª,
Prof. M.e Alexandre Vieira Maschio, da **Universidade Federal da Paraíba - UFPB**.

Faço este contato devido a vossa associação como docente e de vossa condição de Coordenador(a) do Curso de **Mídias Digitais** de vossa instituição.

Sou o Prof. Alexandre V. Maschio, docente na Universidade Federal da Paraíba - UFPB, atualmente realizando meu doutoramento em Mídias Digitais na Faculdade de Ciências e Tecnologia (FCT) da Universidade Nova de Lisboa (UNL) em Lisboa, Portugal.

Venho por meio deste e-mail *solicitar vosso auxílio*, transmitindo (encaminhando) esta minha mensagem aos professores de vossa instituição/curso que trabalhem com disciplinas relacionadas com a produção de efeitos visuais em audiovisual (VFX), ou disciplinas que de alguma forma se relacionam com o tema, como modelagem e animação 3D, composição, pós-produção, efeitos especiais.

Muito obrigado pelo apoio.

Aos professores da área audiovisual e computação gráfica:

Venho por meio deste e-mail primeiramente convidá-lo a conhecer a ferramenta digital de auxílio à docência (objeto de aprendizagem) que produzi durante o doutorado, para auxiliar os professores da área audiovisual no ensino de efeitos visuais (integração entre imagens reais e imagens virtuais - *match moving*).

No website abaixo, poderá obter informações mais detalhadas sobre a ferramenta e ter acesso a estrutura instrucional (na aba "*Learning Objects*") sobre como poderá utilizá-la no contexto pedagógico.

O site sobre o doutoramento e a ferramenta é este abaixo:
https://sites.google.com/campus.fct.unl.pt/digital-media-phd-website-avm

Caso queira ir diretamente a ferramenta, pode utilizar o link abaixo:
https://goo.gl/forms/OxeEF6F5Wor3rtSP2

Em um segundo momento (de vital importância para esta pesquisa) convido vossa senhoria a **participar da pesquisa a respeito desta ferramenta** que lhe apresento.

Caso possa contribuir para a pesquisa – insisto que é muito importante para o desenvolvimento de novas ferramentas pedagógicas digitais (objeto de aprendizagem digital) – **Basta seguir os três procedimentos abaixo**:

1 – **Acessar o site acima e conhecer a ferramenta**: pode testá-la pessoalmente em um projeto prático, em sala de aula com os alunos, ou apenas visualizar as opções que a ferramenta lhe proporciona; além de observar a estrutura instrucional de apoio presente no website;

2 – **Ler a assinar o "**Termo de Consentimento Livre e Esclarecido**"**;
Acessar através do link abaixo.
https://forms.gle/F1J1vgkPyU5JXczAA

Esclarecimento: Documento necessário devido ao registro desta pesquisa junto ao Comitê de Ética em Pesquisa.

3 – **Responder a estes dois formulários de pesquisa** que se encontram nos links abaixo.

https://forms.gle/Cq3CtWxTXe7Fv3zj9

https://forms.gle/pfe2b1y48bfvgW5E8

Sua participação na pesquisa é de vital importância.

Muito obrigado pela atenção e contribuição.

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Doutorando da Universidade Nova de Lisboa
Faculdade de Ciências e Tecnologia
Professor Adjunto da Universidade Federal da Paraíba
Curso de Comunicação em Mídias Digitais

XIV. Statistical Test - Crossing Between Relevance and Adequacy

General Linear Model

Notes

Output Created		01-SEPTEMBER-2019 21:37:46
Comments		
Input	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	14
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics are based on all cases with valid data for all variables in the model.
Syntax		GLM Funcionalidadetécnica–seelacumpreseuspropósitosauxílionacol Facilidadedeuso–percepçãodefacilidadedeusodaferramenta_A Objetivospedagógicos–identificáveiseadequadosaopúblicoalvo Objetivospedagógicos–identificáveiseadequadosaopúblicoalv_A Utilidade–percepçãodequeautilizaçãodaferramentaéválida Utilidade–percepçãodequeautilizaçãodaferramentaéválida_A Auxílionoaprendizado–proporcionadopelaferramentaenquantorecur Auxílionoaprendizado–proporcionadopelaferramentaenquantorec_A Qualidadedosconteúdos–conceitosinformaçõesreferênciasimage Qualidadedosconteúdos–conceitosinformaçõesreferênciasima_A /WSFACTOR=importância 2 Polynomial /MEASURE=func1 obj2 ultil1 aux1 qual1 /METHOD=SSTYPE(3)
Resources	Processor Time	00:00:00,84
	Elapsed Time	00:00:00,61

Within-Subjects Factors

Measure		Dependent Variable
func1	1	Funcionalidadetécnica–seelacumpreseuspropósitosauxílionacol
	2	Facilidadedeuso–percepçãodefacilidadedeusodaferramenta_A
obj2	1	Objetivospedagógicos–identificáveiseadequadosaopúblicoalvo
	2	Objetivospedagógicos–identificáveiseadequadosaopúblicoalv_A
ultil1	1	Utilidade–percepçãodequeautilizaçãodaferramentaéválida
	2	Utilidade–percepçãodequeautilizaçãodaferramentaéválida_A
aux1	1	Auxílionoaprendizado–proporcionadopelaferramentaenquantorecur
	2	Auxílionoaprendizado–proporcionadopelaferramentaenquantorec_A
qual1	1	Qualidadedosconteúdos–conceitosinformaçõesreferênciasimage

2	Qualidadedosconteúdos–conceitosinformaçõesreferênciasima_A

Descriptive Statistics

	Mean	Std. Deviation	N
Funcionalidade técnica – se ela cumpre seus propósitos: auxílio na coleta de dados e automatização na transferência destes para software de computação gráfica 3D.	96,0265	4,02113	14
Facilidade de uso – percepção de facilidade de uso da ferramenta.	1,6942	2,84489	14
Objetivos pedagógicos – identificáveis e adequados ao público alvo. Auxílio nas atividades práticas de produção audiovisual com interação real x virtual.	55,5155	28,25360	14
Objetivos pedagógicos – identificáveis e adequados ao público alvo. Auxílio nas atividades práticas de produção audiovisual com interação real x virtual.	61,4118	35,37925	14
Utilidade – percepção de que a utilização da ferramenta é válida.	69,0153	22,93962	14
Utilidade – percepção de que a utilização da ferramenta é válida.	50,000	0,0000	14
Auxílio no aprendizado – proporcionado pela ferramenta enquanto recurso educacional (objeto de aprendizagem).	66,3364	25,27956	14
Auxílio no aprendizado – proporcionado pela ferramenta enquanto recurso educacional (objeto de aprendizagem).	49,0934	38,76776	14
Qualidade dos conteúdos – conceitos, informações, referências, imagens etc., utilizados na ferramenta (reforçam pontos chave e ideias significativas).	75,5943	20,82877	14
Qualidade dos conteúdos – conceitos, informações, referências, imagens etc., utilizados na ferramenta (reforçam pontos chave e ideias significativas).	26,5540	33,07717	14

Multivariate Tests[a]

Effect			Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Between Subjects	Intercept	Pillai's Trace	0,999	1691,370[b]	5,000	9,000	0,000	0,999	8456,849	1,000
		Wilks' Lambda	0,001	1691,370[b]	5,000	9,000	0,000	0,999	8456,849	1,000
		Hotelling's Trace	939,650	1691,370[b]	5,000	9,000	0,000	0,999	8456,849	1,000
		Roy's Largest Root	939,650	1691,370[b]	5,000	9,000	0,000	0,999	8456,849	1,000
Within Subjects	importância	Pillai's Trace	0,998	1106,234[b]	5,000	9,000	0,000	0,998	5531,172	1,000
		Wilks' Lambda	0,002	1106,234[b]	5,000	9,000	0,000	0,998	5531,172	1,000
		Hotelling's Trace	614,575	1106,234[b]	5,000	9,000	0,000	0,998	5531,172	1,000
		Roy's Largest Root	614,575	1106,234[b]	5,000	9,000	0,000	0,998	5531,172	1,000

a. Design: Intercept
Within Subjects Design: importância

b. Exact statistic

c. Computed using alpha = ,05

Mauchly's Test of Sphericity[a]

Within Subjects Effect		Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Huynh-Feldt	Lower-bound
importância	func1	1,000	0,000	0		1,000	1,000	1,000
	obj2	1,000	0,000	0		1,000	1,000	1,000
	ultil1	1,000	0,000	0		1,000	1,000	1,000
	aux1	1,000	0,000	0		1,000	1,000	1,000
	qual1	1,000	0,000	0		1,000	1,000	1,000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: importância

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Multivariate[a,b]

Within Subjects Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[d]
importância	Pillai's Trace	0,998	1106,234[c]	5,000	9,000	0,000	0,998	5531,172	1,000
	Wilks' Lambda	0,002	1106,234[c]	5,000	9,000	0,000	0,998	5531,172	1,000
	Hotelling's Trace	614,575	1106,234[c]	5,000	9,000	0,000	0,998	5531,172	1,000
	Roy's Largest Root	614,575	1106,234[c]	5,000	9,000	0,000	0,998	5531,172	1,000

a. Design: Intercept
Within Subjects Design: importância

b. Tests are based on averaged variables.

c. Exact statistic

d. Computed using alpha = ,05

Univariate Tests

Source			Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
importância	func1	Sphericity Assumed	62290,023	1	62290,023	6962,956	0,000	0,998	6962,956	1,000
		Greenhouse-Geisser	62290,023	1,000	62290,023	6962,956	0,000	0,998	6962,956	1,000
		Huynh-Feldt	62290,023	1,000	62290,023	6962,956	0,000	0,998	6962,956	1,000
		Lower-bound	62290,023	1,000	62290,023	6962,956	0,000	0,998	6962,956	1,000
	obj2	Sphericity Assumed	243,359	1	243,359	0,352	0,563	0,026	0,352	0,085
		Greenhouse-Geisser	243,359	1,000	243,359	0,352	0,563	0,026	0,352	0,085
		Huynh-Feldt	243,359	1,000	243,359	0,352	0,563	0,026	0,352	0,085
		Lower-bound	243,359	1,000	243,359	0,352	0,563	0,026	0,352	0,085
	ultil1	Sphericity Assumed	2531,071	1	2531,071	9,620	0,008	0,425	9,620	0,818
		Greenhouse-Geisser	2531,071	1,000	2531,071	9,620	0,008	0,425	9,620	0,818
		Huynh-Feldt	2531,071	1,000	2531,071	9,620	0,008	0,425	9,620	0,818
		Lower-bound	2531,071	1,000	2531,071	9,620	0,008	0,425	9,620	0,818
	aux1	Sphericity Assumed	2081,242	1	2081,242	2,747	0,121	0,174	2,747	0,336
		Greenhouse-Geisser	2081,242	1,000	2081,242	2,747	0,121	0,174	2,747	0,336
		Huynh-Feldt	2081,242	1,000	2081,242	2,747	0,121	0,174	2,747	0,336
		Lower-bound	2081,242	1,000	2081,242	2,747	0,121	0,174	2,747	0,336
	qual1	Sphericity Assumed	16834,602	1	16834,602	46,610	0,000	0,782	46,610	1,000
		Greenhouse-Geisser	16834,602	1,000	16834,602	46,610	0,000	0,782	46,610	1,000
		Huynh-Feldt	16834,602	1,000	16834,602	46,610	0,000	0,782	46,610	1,000
		Lower-bound	16834,602	1,000	16834,602	46,610	0,000	0,782	46,610	1,000
Error(importância)	func1	Sphericity Assumed	116,297	13	8,946					
		Greenhouse-Geisser	116,297	13,000	8,946					
		Huynh-Feldt	116,297	13,000	8,946					
		Lower-bound	116,297	13,000	8,946					
	obj2	Sphericity Assumed	8991,074	13	691,621					
		Greenhouse-Geisser	8991,074	13,000	691,621					
		Huynh-Feldt	8991,074	13,000	691,621					
		Lower-bound	8991,074	13,000	691,621					
	ultil1	Sphericity Assumed	3420,471	13	263,113					
		Greenhouse-Geisser	3420,471	13,000	263,113					
		Huynh-Feldt	3420,471	13,000	263,113					
		Lower-bound	3420,471	13,000	263,113					
	aux1	Sphericity Assumed	9848,625	13	757,587					
		Greenhouse-Geisser	9848,625	13,000	757,587					
		Huynh-Feldt	9848,625	13,000	757,587					
		Lower-bound	9848,625	13,000	757,587					
	qual1	Sphericity Assumed	4695,389	13	361,184					
		Greenhouse-Geisser	4695,389	13,000	361,184					
		Huynh-Feldt	4695,389	13,000	361,184					
		Lower-bound	4695,389	13,000	361,184					

a. Computed using alpha = ,05

Tests of Within-Subjects Contrasts

Source			Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
importância	func1	Linear	62290,023	1	62290,023	6962,956	0,000	0,998	6962,956	1,000
	obj2	Linear	243,359	1	243,359	0,352	0,563	0,026	0,352	0,085
	ultil1	Linear	2531,071	1	2531,071	9,620	0,008	0,425	9,620	0,818
	aux1	Linear	2081,242	1	2081,242	2,747	0,121	0,174	2,747	0,336
	qual1	Linear	16834,602	1	16834,602	46,610	0,000	0,782	46,610	1,000
Error(importância)	func1	Linear	116,297	13	8,946					
	obj2	Linear	8991,074	13	691,621					
	ultil1	Linear	3420,471	13	263,113					
	aux1	Linear	9848,625	13	757,587					
	qual1	Linear	4695,389	13	361,184					

a. Computed using alpha = ,05

Tests of Between-Subjects Effects

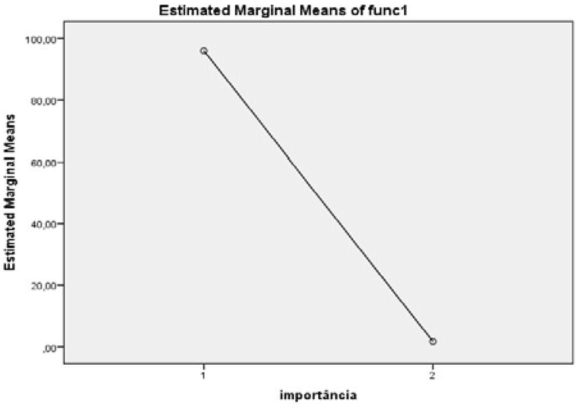
Transformed Variable: Average

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	func1	66845,334	1	66845,334	4364,121	0,000	0,997	4364,121	1,000
	obj2	95703,937	1	95703,937	70,457	0,000	0,844	70,457	1,000
	ultil1	99152,491	1	99152,491	376,844	0,000	0,967	376,844	1,000
	aux1	93268,231	1	93268,231	67,370	0,000	0,838	67,370	1,000
	qual1	73039,944	1	73039,944	62,601	0,000	0,828	62,601	1,000
Error	func1	199,121	13	15,317					
	obj2	17658,370	13	1358,336					
	ultil1	3420,471	13	263,113					
	aux1	17997,318	13	1384,409					
	qual1	15167,789	13	1166,753					

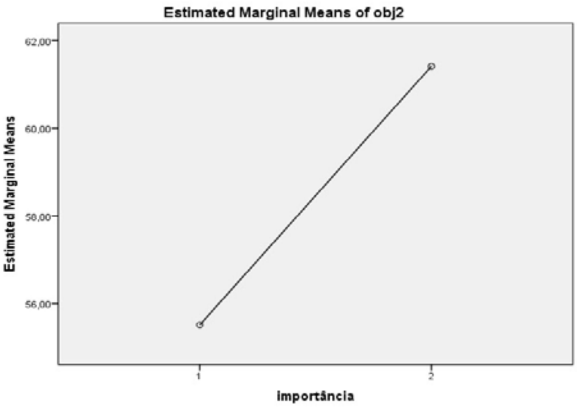
a. Computed using alpha = ,05

Profile Plots

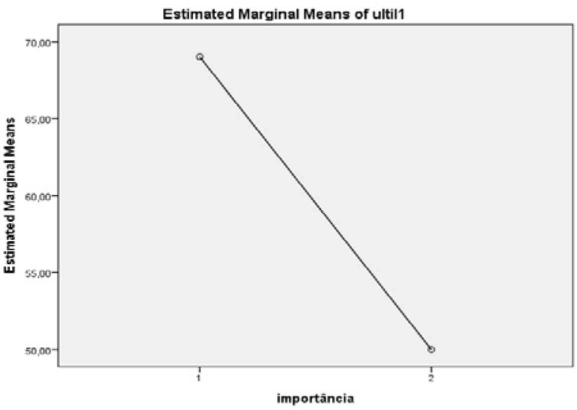
func1



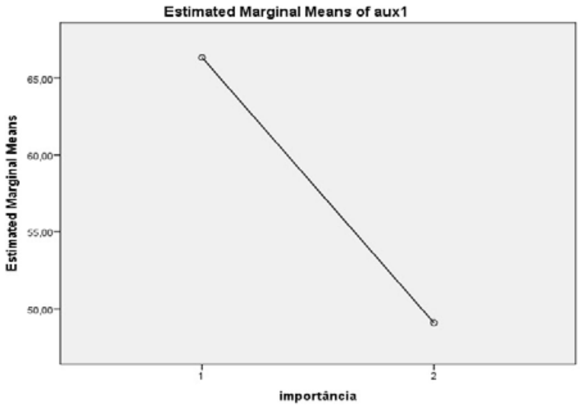
obj2



ultil1



aux1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Estimated Marginal Means
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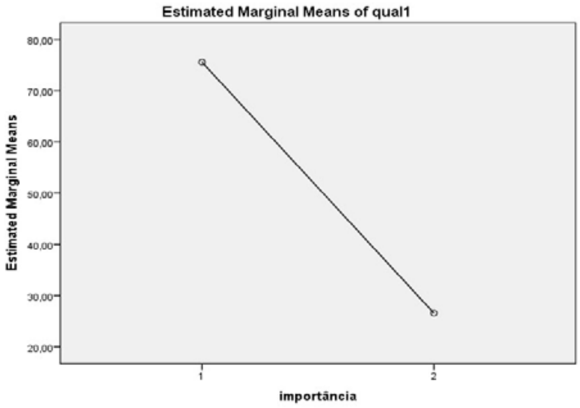
60,00
55,00
50,00
1
2
importância

qual1


Estimated Marginal Means of qual1
Estimated Marginal Means
80,00
70,00
60,00
50,00
40,00
30,00
20,00
1
2
importância

XV. Statistical Test - Blind Analysis of the Audiovisual Works

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GLM SemFerramenta ComFerramenta
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  /EMMEANS=TABLES(Ferramenta) COMPARE ADJ(LSD)
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General Linear Model

Notes

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	Cases Used	Statistics are based on all cases with valid data for all variables in the model.
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Within-Subjects Factors

Measure: MEASURE_1

Ferramenta	Dependent Variable
1	SemFerramenta
2	ComFerramenta

Descriptive Statistics

	Mean	Std. Deviation	N
Sem Ferramenta	6,8357	0,85360	14
Com Ferramenta	6,6000	1,00460	14

Multivariate Tests[a]

Effect		Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[c]
Ferramenta	Pillai's Trace	0,065	,902[b]	1,000	13,000	0,360	0,065	0,902	0,143
	Wilks' Lambda	0,935	,902[b]	1,000	13,000	0,360	0,065	0,902	0,143
	Hotelling's Trace	0,069	,902[b]	1,000	13,000	0,360	0,065	0,902	0,143
	Roy's Largest Root	0,069	,902[b]	1,000	13,000	0,360	0,065	0,902	0,143

a. Design: Intercept
Within Subjects Design: Ferramenta

b. Exact statistic

c. Computed using alpha = ,05

Mauchly's Test of Sphericity[a]

Measure: MEASURE_1

Within Subjects Effect	Mauchly's W	Approx. Chi-Square	df	Sig.	Epsilon[b] Greenhouse-Geisser	Epsilon[b] Huynh-Feldt	Epsilon[b] Lower-bound
Ferramenta	1,000	0,000	0		1,000	1,000	1,000

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. Design: Intercept
Within Subjects Design: Ferramenta

b. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

Tests of Within-Subjects Effects

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Ferramenta	Sphericity Assumed	0,389	1	0,389	0,902	0,360	0,065	0,902	0,143
	Greenhouse-Geisser	0,389	1,000	0,389	0,902	0,360	0,065	0,902	0,143
	Huynh-Feldt	0,389	1,000	0,389	0,902	0,360	0,065	0,902	0,143
	Lower-bound	0,389	1,000	0,389	0,902	0,360	0,065	0,902	0,143
Error(Ferramenta)	Sphericity Assumed	5,606	13	0,431					
	Greenhouse-Geisser	5,606	13,000	0,431					
	Huynh-Feldt	5,606	13,000	0,431					
	Lower-bound	5,606	13,000	0,431					

a. Computed using alpha = ,05

Tests of Within-Subjects Contrasts

Measure: MEASURE_1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Ferramenta	Linear	0,389	1	0,389	0,902	0,360	0,065	0,902	0,143
Error(Ferramenta)	Linear	5,606	13	0,431					

a. Computed using alpha = ,05

Tests of Between-Subjects Effects

Measure: MEASURE_1
Transformed Variable: Average

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[a]
Intercept	1263,629	1	1263,629	967,097	0,000	0,987	967,097	1,000
Error	16,986	13	1,307					

a. Computed using alpha = ,05

Estimated Marginal Means

Ferramenta

Estimates

Measure: MEASURE_1

Ferramenta	Mean	Std. Error	95% Confidence Interval Lower Bound	95% Confidence Interval Upper Bound
1	6,836	0,228	6,343	7,329
2	6,600	0,268	6,020	7,180

Pairwise Comparisons

Measure: MEASURE_1

(I) Ferramenta	(J) Ferramenta	Mean Difference (I-J)	Std. Error	Sig.[a]	95% Confidence Interval for Difference[a] Lower Bound	95% Confidence Interval for Difference[a] Upper Bound
1	2	0,236	0,248	0,360	-0,300	0,772
2	1	-0,236	0,248	0,360	-0,772	0,300

Based on estimated marginal means
a. Adjustment for multiple comparisons: Least Significant Difference (equivalent to no adjustments).

Multivariate Tests

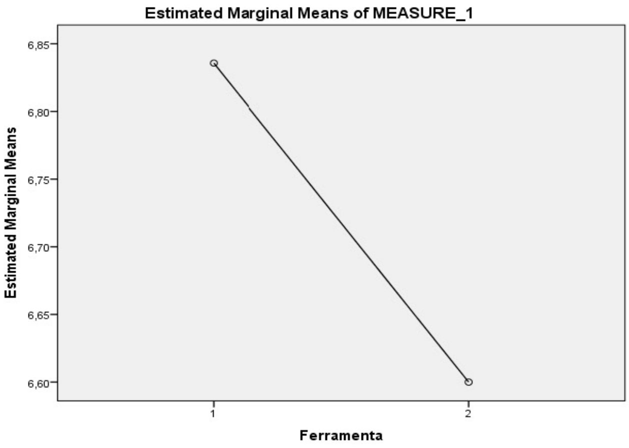
	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power[b]
Pillai's trace	0,065	,902[a]	1,000	13,000	0,360	0,065	0,902	0,143
Wilks' lambda	0,935	,902[a]	1,000	13,000	0,360	0,065	0,902	0,143
Hotelling's trace	0,069	,902[a]	1,000	13,000	0,360	0,065	0,902	0,143
Roy's largest root	0,069	,902[a]	1,000	13,000	0,360	0,065	0,902	0,143

Each F tests the multivariate effect of Ferramenta. These tests are based on the linearly independent pairwise comparisons among the estimated marginal means.

a. Exact statistic

b. Computed using alpha = ,05

Profile Plots


Estimated Marginal Means of MEASURE_1
Estimated Marginal Means
6,85
6,80
6,75
6,70
6,65
6,60
1
2
Ferramenta